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SOIL EROSION AND SOIL CONSERVATION.

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SUMMARY.

The question of soil erosion and soil conservation is receiving considerable attention in various parts of the world, particularly in the United States of America.

A review is given of the situation in America and some mention is made of the occurrence in other countries.

The factors responsible for soil erosion are discussed.

Soil erosion problems have not yet assumed serious proportions generally in Western Australia, but sufficient damage has been done under some conditions to warrant farmers' attention being drawn to the situation and to the need for the development of a soil conscience.

The means of control of soil erosion and the promotion of soil conservation are discussed.

AGRICULTURE IN A NEW COUNTRY.

In the early development of a newly-found continent for agriculture in a modern civilisation many mistakes are inevitably made and these may lead to serious consequences in the course of decades. A useful field of study of such consequences is the North American continent which was settled by Europeans about 300 years ago, but where much of the agricultural development is but 50 to 75 years old. The present soil conditions resulting from the extension of agriculture in the U.S.A. are being systematically studied by the recently organised Soil Conservation Service, and the reports published afford a wealth of information as well as a timely warning for the agricultural community of Australia. On this account it is deemed desirable to present some of the most important facts for the information of farmers in W.A.

Continental United States covers an area of nearly 2,000,000,000 acres and half of this area is being used as farm lands by about 6,500,000 farmers. The farm population amounts to some 30,000,000 people. As in all pioneer development, settlers and their families cleared the forests, ploughed up the grasslands and planted their crops, and the soils have had practically no rest ever since.

The wastage has been enormous. Land, denuded of its former cover, has been at the mercy of wind and rain. Erosion due to both wind and rain has taken heavy toll of the fertile surface soil; excessive leaching has depleted soils of plant foods; excessive run-off of water has caused scouring which has resulted in the covering of fertile valleys with sand and gravel; excessive irrigation has led to the rise of the watertable and salt encroachment; overstocking has resulted in the ruination of range pastures. In too many cases these conditions have led to derelict farms, impoverished families and community problems such as destructive floods, the silting up of streams and reservoirs and the spread of uncontrolled pests. These are important factors underlying the proposal to withdraw 454,000 submarginal farms covering 25,000,000 acres from cultivation in the U.S.A. (Barrows, 1936).

Of course, warnings had been given, but had gone unheeded and the nation in 1930 found its agriculture faced with a problem of soil depletion probably unparalleled in the history of a young nation. In so many instances the farmers had been *mining* the land rather than *farming* it. So acute had the problem become that the Federal Government created in 1934 a "Soil Conservation Service" staffed by the best brains of the country, and appropriated in November, 1933, over a million pounds sterling for a survey of conditions and the establishment of experimental areas. A like sum was made available the following year. The magnitude of the work planned by this service may be gauged by the sum of £450,000 (sterling) included for this purpose in the 1936-37 budget.

The first work of the Soil Conservation Service was a survey of the magnitude of the damage already suffered. At the same time a commencement was made on the investigation of the fundamental factors contributing to soil erosion and land deterioration. The third phase of the work is the practical control of the problem and the reclamation of damaged areas.

The Magnitude of the Damage.

The total area of the U.S.A., exclusive of city and water territory, amounts to 1,907,000,000 acres, and the area damaged as a result of the agencies of wind and water is estimated as follows ("Saving the Soil," U.S.D.A. AAA leaflet G53, Mar. 1936):—

	Acres.
Gully erosion:	
Severely damaged	337,000,000
Unfit for cultivation	4,000,000
Sheet erosion:	
Slight to severe	900,000,000
Wind erosion	300,000,000

(It is estimated that 113,000,000 acres have been essentially destroyed for further tillage (Lowdermilk (1935).)

It is probable that these figures are high and over-emphasise the seriousness of the situation, but they do draw attention to a very serious condition.

THE SOIL EROSION PROBLEM.

The most severe and insidious wastage is caused by sheet erosion. Under cultivation the surface soil is gradually washed away and eventually the most important part of the soil for crop growth, the humus layer, is lost, and the farmer becomes what is known as a "subsoil farmer." Fig. 1 illustrates what happens in sheet erosion.

Gully erosion is severe, but is more obvious. It is thus easier to realise the need for control and to effect some relief. It is caused by running water cutting gutters down slopes and thus removing valuable top soil and interfering with cultural activities.

The semi-arid regions of the Great Plains immediately east of the Rocky Mountains have suffered most from wind erosion. It is the result of injudicious cultivation, over-grazing, and the depletion of the humus supply. These abuses have damaged the soil structure to such an extent that it is sucked up by wind during drought periods. The finer fractions are removed in the form of dust, and the sand accumulates in hummocks and ridges.

The measurement of losses in the U.S.A. shows that soil erosion by various agencies has been responsible for the removal of 21 times the amount of plant food as is absorbed by the crops themselves (U.S.D.A. Yearbook, 1933, p. 59).

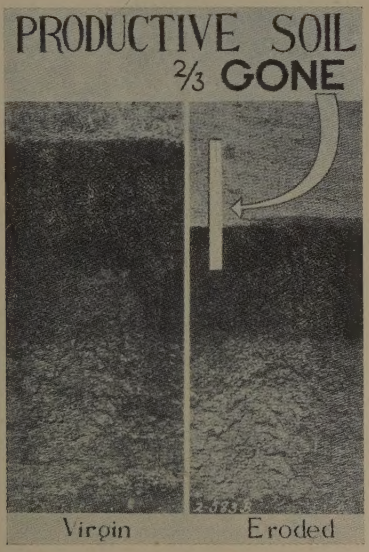

Fig. 1.

A comparison of the Shelby loam profiles in virgin and cultivated fields. Erosion has removed 8 inches, or two-thirds of the original surface soil. (Missouri A.E.S. Bul. 349, Fig. 1, p. 7.)

This fact shows how ineffective is the usual fertiliser programme as a means for the maintenance of soil fertility, and emphasises the need for an organised effort to prevent the wastage by careful farm management as well as fertiliser application.

The problem is the accommodation of agricultural practice to the soil and climatic conditions so that the building-up processes at least equal those of degradation.

The incidence of the water erosion problem in the U.S.A. can best be gauged from a consideration in more detail of the position in a State seriously affected. The Missouri Agricultural Experiment Station has published a bulletin (Baver

(1935)) dealing with the problem in that State, and the information in this publication will serve for this purpose.

In the first instance a system of classification of the degree of erosion was devised, and it was found that four main erosion classes could be identified.

1. None to slight erosion: less than one-fourth of the surface soil had been removed and gullying was occasional to moderate.
2. Moderate to serious erosion: from one-quarter to one-half of the surface soil removed by moderate sheet erosion and occasional to moderate gullying (see Fig. 2).
3. Serious to severe erosion: from one-half to three-quarters of the surface removed.
   A. Serious sheet erosion. (See Fig. 3.)
   B. Serious sheet erosion with serious gullying. (See Fig. 4.)
4. Severe to excessive erosion: over three-fourths of the surface removed by sheet erosion and gullying rendering the country difficult or practically unfit for cultivation. (See Figs. 5 and 6.)

Fig. 2.

Moderate to serious erosion—one-quarter to one-half of the surface soil has been washed away. The flow of water down the rows of maize has removed large quantities of top soil. (Missouri A.E.S. Bul. 349, Fig. 5, p. 48.)

On this basis of classification the incidence of water erosion in Missouri is given in Table 1.

TABLE 1.

Extent of Erosion in Missouri.

Type of Erosion.	Average amount of original surface soil washed away.	Acres.	Percentage of land area of State.
1. None to slight	0—$\frac{1}{4}$	10,000,000	23
2. Moderate to serious	$\frac{1}{4}$—$\frac{1}{2}$	12,000,000	27
3. Serious to severe	$\frac{1}{2}$—$\frac{3}{4}$	20,000,000	45
4. Severe to excessive ...	over $\frac{3}{4}$	2,000,000	5
Total	...	44,000,000	100

Fig. 3.

On a 1 in 8 slope sheet erosion has been serious and gullying moderate. From one-half to three-quarters of the top soil has been removed. (Missouri A.E.S. Bul. 349, Fig. 2, p. 30.)

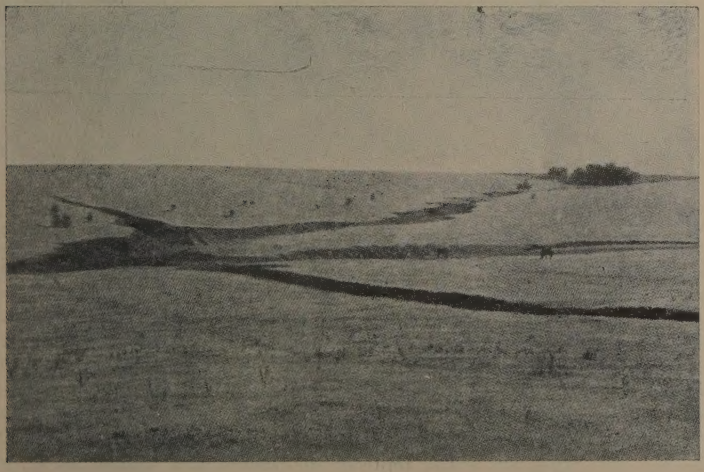

Fig. 4.

Both sheet erosion and gullying have been severe and from one-half to three-quarters of the top soil has been removed. The number of deep gutters seriously interferes with agricultural practice. (Missouri A.E.S. Bul. 349, Fig. 3, p. 37.)

It is certainly difficult to realise that the most reliable estimates available show that 77 per cent. of the total land surface of Missouri has lost more than one-quarter of its surface soil through soil erosion. In terms of plant foods the loss has amounted to:—

26,090,000 tons of nitrogen,
13,030,000 tons of phosphorus,
300,240,000 tons of potassium,

and there is no doubt that this loss is one of the major causes of decreased land values and financial embarrassment among farmers in Missouri.

Wind erosion occurs to some extent in practically all States, but it is most severe in the drier prairie regions immediately east of the Rocky Mountain foothills. The States of Colorado, New Mexico, Oklahoma, Texas and Western Kansas are probably most seriously affected, but the condition extends northward through Nebraska, Eastern Montana, North and South Dakota and into Canada.

Fig. 5.

Sheet erosion and gullying have removed over three-quarters of the top soil. (Missouri A.E.S. Bul. 349, Fig. 4, p. 39.)

This country in the virgin state consisted of slightly rolling grassy plains and much of the soil of the area is formed from wind-blown material known as loess. While the grass cover persisted and the surface soil was full of roots wind erosion was restricted, but with the introduction of large-scale farming methods this protection was destroyed and the winds once again caused the movement of the soil material. Several years of drought have accentuated the condition and the havoc caused by the wind has been evidenced throughout the United States by the occurrence of unprecedented duststorms. In a portion of Colorado known as the "dust bowl" (Hibbs (1936)) once-cultivated lands have been damaged by sand drifts and by the removal of top soil to the depth of the plough sole. About 4,000,000 acres have been essentially destroyed by wind erosion in this region.

The Causes of Soil Erosion.

The immediate causes of soil erosion are climatic, being functions of rainfall and wind action.

A.—*Water Erosion.*

The rate of erosion by water is determined by the run-off which is a function of:—

1. Intensity of rainfall;
2. slope of the land;
3. length of the slope;
4. the nature of the soil;
5. the vegetation growing on the soil.

1. *The intensity of the rainfall.*

Heavy rains, particularly on a dry soil, are conducive to excessive run-off. Nothing can be done to modify the rainfall but farmers can do much towards the elimination of damage by the adoption of sound farm practice designed to minimise the amount for the rainfall lost as run-off.

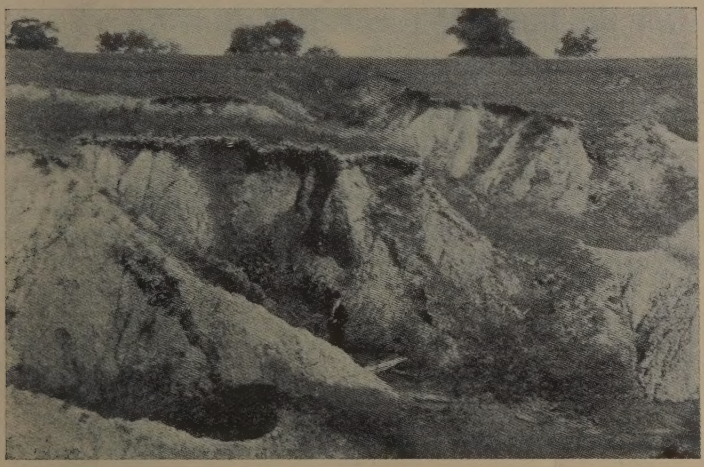

Fig. 6.

Excessive gullying which has practically ruined the land for agriculture. (Missouri A.E.S. Bul. 349, Fig. 6, p. 55.)

2. *The slope of the land.*

It is practically impossible to alter the slope of the land and again the control of this factor involves adaptation of farming methods to natural conditions. In Missouri it is found that little or no erosion is likely to occur on land with less than a 1 in 30 (3 per cent.) slope. Land with slopes ranging from 1 in 30 to about 1 in 10 or 1 in 12 are liable to severe erosion, particularly if planted continuously with intertilled crops such as maize or cotton. Run-off is accelerated by planting up and down the slope instead of across it and this leads to a severe scouring effect even on quite low slopes.

Most of the severe erosion occurs on slopes steeper than about 1 in 10 and it is doubtful if these lands should be cultivated except under special circumstances. The higher slopes are more adapted to pasture and forestry than to cultivation.

3. *The length of the slope.*

Long slopes allow the accumulation of moving water and so the damage is accentuated unless some means is taken to break the slopes and prevent the surface movement of large amounts of water.

4. *The nature of the soil.*

The principal soil factors conducive to water erosion are:—

(a) The ability of the soil to allow water to percolate;

(b) the amount of water that the soil can absorb.

Soils with a more or less porous surface resting on a heavy clay or other impermeable subsoil, which restricts absorption and drainage, are most liable to erosion. When cultivation has destroyed the leaf litter and binding roots, the surface soils readily become saturated with water and in this condition erode rapidly and the subsoil becomes exposed. Soil types showing these characteristics in sloping country will need careful management to prevent erosion. One of the chief factors in the maintenance of soils in a condition to retard erosion is the conservation of soil organic matter which stabilises the soil structure, tends to bind the surface as a layer, and increases the capacity of the soil to hold water.

5. *The vegetation growing on the soil.*

Bare soil is always liable to erosion, either by water or by wind, and farmers must be judicious in their use of fallow and intertilled crops where erosion is liable to occur. The crop rotation must be adapted to suit the conditions and preserve a favourable balance in the soil economy.

In a review of the situation in U.S.A., H. H. Bennett (1935) states that on the Shelby silt loam with a 1 in 12 (8 per cent.) slope the run-off of water and the amount of soil eroded under different cultural treatments was found to be as given in Table 2.

TABLE 2.

Run-off and Erosion of Shelby Silt Loam under different cultural treatments.
Slope—1 in 12.
(Measurements at Berhany, Missouri.)

Crop.	Run-off. per cent. of total rainfall.	Erosion. tons of soil per acre per annum.
Maize (intertilled)	27	60
Lucerne	3·41	0·21
Timothy grass	7·74	0·32
Bare fallow	...	112
Rotation—Corn-wheat-clover-clover	11	9·9

B.—*Wind erosion.*

The principal factors in wind erosion are soil texture, soil structure, climatic conditions and the vegetation cover of the soil.

It is found that fine sand, particularly when the grains are more or less rounded, are most liable to move under the action of the wind. Not only sand grains, but also small aggregates of clay of the same size are affected by wind action. As described by Kellogg (1935), the prolonged droughty period in the western wheat lands of the U.S.A. has caused the lumpy structure of soils to break down to a fine granular condition, and even fine clay soils in this condition have been damaged by wind erosion. As many of these soils are derived from

wind blown material it can be readily understood that wind erosion will always be a potential problem, and the circumstances demand management programmes calculated to counteract the tendency.

In periods of drought and high winds the incidence of the problem will be accentuated.

Under the cover of the indigenous buffalo and grama grasses the soil is protected, but when the land is broken up for wheat production the organic matter is rapidly destroyed and the stability of the soil structure is decreased. In some instances the brief periof of five years under extensive wheat farming has been sufficient to cause severe damage as a result of wind erosion.

The Erosion Problem in other parts of the World.

Attention has been given to the problem of soil erosion in other parts of the world, and the results of the investigations give important information for the evaluation and attack of the problem.

As a result of overstocking, fires and the abandonment of cleared land, the Sahara desert is encroaching southward at the rate of nalf a mile per annum (Science Supplements (1935)).

The erosion problem in South Africa has been investigated by a number of commissions, and the latest report covers deliberations at the Empire Forestry Conference (1935). The most serious problem occurs over an area of 26,000,000 acres under a 10-20 inch rainfall and below the escarpment of the plateau of the Karoo formation. The natural erosion has been accelerated by the increased run-off following uncontrolled veld burning and localised overstocking under the kraal system of management. The result has been serious not only in damaging the soil, but in leading to the drying up of springs, to the rivers becoming intermittent torrents following downpours, and to the silting up of reservoirs and irrigation channels.

In India the problem has arisen with the throwing open of forests to the use of villagers. This has led to their destruction in the course of 150 years, and the desolation of hilly country by overgrazing and soil erosion has followed the removal of the timber. Many authorities, too, believe that the decay of many ancient civilisations, such as existed in Persia and Central Africa, has been due to injudicious management of the country, which has resulted in soil impoverishment and soil erosion. The intermittent floods and famines in China are due, at least in part, to the indiscriminate removal of timber from the watersheds.

Soil Erosion in Australia.

Some concern has been expressed in Australia concerning soil erosion, and a number of reports have been prepared (Ratcliffe, 1936; Committee on Sand Drift in Victorian Mallee, 1933; Galbraith, Empire Forestry Conference, 1935). Some erosion and gullying is occurring on the watersheds of the Eastern States rivers, and sand drft has always been a problem in the mallee country.

According to Ratcliffe the results of overgrazing in South Australian pastoral areas have reduced the saltbush and bluebush cover to 10 per cent. to 25 per cent. of the virgin condition, and the mulga scrub has also suffered. Reports from this arid area led to Ratcliffe's investigation, which shows a serious amount of wind erosion following the damage to the native vegetation. Fortunately, there are indications that the sand is generally not moving any considerable distance, but is confined to the areas where the vegetation has been damaged by overgrazing. Regeneration on moving soil is extremely difficult, and the outlook for some areas in these dry pastoral districts does not appear bright.

Farmers and pastoralists of Western Australia are not as yet faced with a serious problem in soil erosion, but there are unmistakable signs that certain areas are suffering and require more careful management (Gardner (1936)). Steps should be taken to insure the early adoption of the best practice in order to avoid the trouble experienced by others. Fortunately, the physical characters of most of the principal soil types of Western Australia appear to resist soil erosion rather effectively, but there is no doubt that the rate of erosion increases rapidly as the process continues. Even if the action is very slow in the early stages of development, if injudicious farm practice leads to soil depletion, accelerated losses can be expected in the future.

In Western Australia the beginnings of a soil erosion problem may be observed under four sets of conditions.

1. *The hilly country of the brown earth zone.*

The brown earth zone practically corresponds with the distribution of jam (Acacia acuminata) and York gum (Eucalyptus foecunda var. loxophleba) and receives an average annual rainfall ranging from 15 inches to 25 inches. The topography is hilly and the soils generally sandy and gritty loams resting on a brown or yellowish clay subsoil. In the virgin state little or no erosion occurs, but when put under cultivation the soil is moderately affected by gullying on the slopes. Furthermore, channels are cut in the shallow valleys. Fallowed land is particularly liable to erosion, and it is inadvisable to drive implements or vehicles up slopes on account of the danger of initiating a gutter down the slope.

A certain amount of sheet erosion is also observed and appears to be somewhat on the increase. Many farmers in the brown earth will recognise the conditions depicted in Figs. 2-6 taken from the Missouri report. Damage over restricted areas is reported in parts of the wheat belt folowing exceptional rains. The floods at Koorda and Gabbin this year were responsible for soil erosion and for the deposition of detrital material.

A minor amount of wind erosion occurs on fallowed land particularly after rains during the summer months. Rains at these times break down the structure of the soil and favour wind erosion.

2. *Hilly orchard country of the South-West.*

The first rains of the winter period generally fall on dry, clean, cultivated soils in the orchards and water absorption is slow. If the rains are heavy, damage to the soil results both from gullying and from sheet erosion where the soil management has not been effective.

3. *Wind erosion in the Wheat Belt.*

Generally the soils of the wheat belt are of granitic or gneissic origin and do not readily suffer from wind erosion. Wind erosion of soils does occur, however, on certain sedimentary formations in the Yuna-Dartmoor districts and in the Salmon Gums districts. A certain amount of wind erosion has occurred in other districts of the north-eastern wheat belt following the 1935 drought. However, no serious damage has yet been done and farmers generally endeavour to organise their farm work to minimise the effect of the wind.

4. *Erosion in the pastoral areas.*

In common with the other parts of the continent where low rainfall country is being opened up for extensive pastoral activities, there are evidences of problems arising from the stocking of the country. Unfortunately, accurate data are very

limited and no estimate of the progress of soil erosion can be made at this time. At the present time, denudation of vegetation and the elimination of the more edible and nutritious species are the more important consequences and actual soil erosion is not important. Quite considerable areas of mulga scrub (Acacia spp.) are dying for no apparent reason and regeneration by seedlings is practically prevented by the depredations of vermin such as kangaroos and wallabies supplementing the action of stock. On some of the more fertile grassy flats quite considerable areas are now bare of vegetation and are known as "claypans." Little movement of soil is noticed on these "claypans" but the smooth surface militates against the establishment of seedlings following rain.

It is generally acknowledged that burning of certain types of scrub land and grassland greatly improves the feeding value. Indiscriminate burning of the veldt in South Africa has had a serious effect and shows that the practice needs very careful control. Once the native vegetation has been eliminated it is certain that regeneration will be extremely difficult.

Control Measures for Soil Erosion.

The control measures adopted will depend on the type of erosion and the conditions. A number of factors will be included in any control programme for soil erosion and the basic principles may be discussed to enable farmers to adopt practices calculated to give a maximum degree of conservation. (Schickele, Himmel and Hurd (1935.))

1. A soil conscience must be developed. The soil is the basis not only of the farmers' food supply, but also that of the community, and the national welfare demands that the farmer build up and preserve soil fertility. The soil miner is the primary influence in need of control.

2. Steep land is most susceptible to erosion by water and should be left to permanent pasture or to timber unless special circumstances warrant its cultivation under a special cropping programme. In the U.S.A. the most severe erosion occurs on slopes steeper than 1 in 10.

The steepest country is often a watershed and protection of watersheds by a forest cover provides an important regulation of water supplies.

3. Soil types most liable to wind or water erosion should be accorded special treatment.

4. The maintenance of soil organic matter is one of the most important factors in the control of erosion. Organic matter facilitates water absorption and stabilises the soil structure. A period under pasture is one of the best methods of building up the soil organic matter. Subterranean clover is already showing its value in this respect in some districts and warrants more extensive use. An effective crop rotation must be adopted under all circumstances.

5. Slopes liable to erosion should always be cultivated and planted on the contour to give a terracing effect. This will retard run-off and promote the absorption of water, a factor of importance in crop growth and the building up of fertility. In extreme cases terracing must be practised. It is a fundamental principle that surface movement of water must be prevented.

6. Gullies must be watched for and controlled at all times. One season is sufficient to cut a field practically in halves by means of a gully and this means extra farming costs. Where gullies have developed a considerable degree of control has been effected in the U.S.A. by the building of small dykes across the channels, to prevent movement of surface water.

7. Wind erosion may be controlled by cultivation across the direction of the prevailing winds, by cultivating the soil so that the surface is left in a cloddy condition, and by growing crops which leave a good strong stubble. Early burning of stubble should be avoided on soil types liable to blow. The use of timber strips to act as a wind break assists in retarding wind erosion. In America, fields are frequently cropped in strips across the direction of the wind to check wind erosion.

8. Overstocking and continuous cultivation are the most serious contributing factors in land deterioration. From 75 to 90 per cent. of the saltbush and bluebush has been eaten out in the pastoral areas of South Australia as a result of overstocking. A repetition of this experience can be avoided in the newer areas. In the agricultural areas crop rotation is essential and the search for improvements in the programme of crop rotation must be continued.

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SUMMER FODDER CROPS IN THE WHEAT BELT.

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The drought conditions which obtain throughout the Western Australian wheat belt for five to seven months in the summer and autumn each year present a serious problem to the farmer who is desirous of growing green fodder during that period. The incidence of summer rains, in the form of occasional monsoonal disturbances and local thunderstorms is so uncertain that it is best to disregard altogether the likelihood of their occurrence when considering the possibility of growing summer crops. On many holdings, however, there are small areas of land which retain their subsoil moisture well into the summer months. On some of these areas water is obtainable at shallow depths right throughout the dry period of the year. Such patches are almost invariably associated with the lighter soil types and they become more numerous subsequent to the clearing of the surrounding country. The water from these underground supplies is often quite fresh and, when this is the case, they prove of considerable value as a site for wells or for the establishment of small areas of summer-growing pasture or fodder plants.

Occasionally quite large areas of light land are sufficiently retentive of moisture to warrant the planting of summer-growing plants. Usually, however, the plot is a small one of an acre or so in extent, but it may, even so, be valuable as a source of supply of green feed for poultry and one or two milking cows during the dry months.

The following brief notes indicate the characteristics, desirable cultural methods, etc., of some of the plants most likely to succeed under the conditions outlined above. Of those considered lucerne, veldt grass, Phalaris tuberosa, and kikuyu grass are perennials, and once established can be regarded as more or less permanent. The remainder are annuals (or sometimes biennials) and seldom survive more than one year.

Lucerne.—This is a hardy deep-rooted, leguminous perennial that succeeds under a wide range of conditions. It is probably the best and hardiest of the summer fodder crops. It can be sown broadcast but, where moisture is a limiting factor, it is best planted in rows about 2 ft. apart at the rate of 4 lbs. of seed per acre. This allows of inter-row cultivation to maintain a mulch and keep down weeds. Lucerne can be planted in autumn, but where moisture is available better results will be obtained by planting in late September with the commencement of the warmer weather. If the land is subject to waterlogging in the winter, however, lucerne should not be sown as it will not thrive under excessively wet conditions. "Hunter River" is the variety that should be sown. The present price of seed is 2s. 6d. per lb. for small lots.

Sudan Grass.—This grass, which is a native of Africa, is one of the most drought resistant of our summer fodder crops. It matures fairly rapidly and under suitable conditions may be ready for cutting two months after seeding.

Growers should make sure that the seed they obtain is true to name. Sudan grass hybridises readily with other members of the sorghum group and the presence of these hybrid plants may cause the symptoms of sorghum poisoning. Providing the crop of Sudan grass is free from sorghum or sorghum hybrids, the risk of poisoning grazing stock is negligible. The crop should be sown about late September at the rate of 3-4 lbs. per acre. If it is to be used for grazing it should be sown

through every tube of the drill. Close sowing gives a finer stem and improves the quality of the grazing. Earlier sowing necessitates heavier seeding as germination is adversely affected by cold weather.

Seed is usually obtainable at about 9d. per lb. for small lots.

Saccaline Sorghum.—Saccaline is a representative of the sweet sorghums. Though not so good a fodder as maize, sorghum will thrive under drier conditions and grow on poorer soils. When the young plants are well established they will withstand drought and respond readily to rain, while maize seldom recovers well after a check.

Sorghum is usually sown in rows about 3 feet apart at the rate of 4-5 lbs. per acre. It can be sown through the seed box of the drill and should be planted 1-2 inches deep.

Early Amber Cane is an earlier maturing variety than "Saccaline" and belongs to the grain sorghum group. It is useful as a green fodder in the drier areas, but is not so prolific as "Saccaline."

Sorghum should not be fed to stock until it comes into head, as in the earlier stages of growth there is a risk of poisoning.

Current seed prices are 9d. per lb. for both "Saccaline" and "Early Amber Cane."

Japanese Millet is another hardy summer-growing plant, which can be grazed at any stage of its growth. It should be sown through every run of the drill at the rate of 8-12 lbs. per acre. In common with the crops previously mentioned it is a heat lover and should not be sown until the advent of the warmer weather.

The present price of seed is 6d. per lb.

Mexican Spinach.—During the past two or three years there has been a revival of interest in this plant in various parts of the wheat belt. It is a hardy, drought-resistant fodder which is of value in the drier districts where better quality plants will not thrive. It remains green well into the summer months even when grown on soils not specially favoured as regards summer moisture.

The chief drawback to its establishment is the erratic germination of the seed Although the plant will make good growth in winter, better germination is likely to result from spring planting, as both warmth and moisture are then available.

The seed, which costs about 6s. per lb., should be sown at the rate of 1-2 lbs. per acre on a firm, well-prepared seed bed.

Kikuyu Grass.—Kikuyu is a drought resistant, summer growing grass which thrives under hot, moist conditions. It is a native of Africa and rarely sets seed under Australian conditions. It is established by planting roots or runners at the rate of about one per square foot. It responds readily to topdressing with superphosphate and sulphate of ammonia. As a lawn grass it is probably superior under wheat belt conditions to either buffalo or couch. It makes some little growth during the cold weather and will withstand cold and waterlogging better than most grasses of this type.

Roots can be obtained from local nurserymen at 7s. 6d. per sack.

Perennial Veldt Grass.—This hardy grass is well worth a trial on sandy soil or on land which holds its moisture through the summer. Experience over the past three years on sandplain country at the Wongan Hills research station has indicated

that it can be established on light land where little summer moisture is available, and that it will persist throughout the driest summer, giving a good bite of green feed with the advent of the winter rains.

Unlike most perennial grasses, it makes good growth in the colder weather, and on suitably moist land would continue to do so through the summer. Under dry conditions it remains dormant through the summer. When in this condition stock should not have access to it as they are likely to eat it down so low as to damage the crown and destroy it; also pull it out by roots.

It is best to establish the grass from roots, which are easily obtainable. (It is a weed in King's Park and its surroundings.) As it seeds prolifically it should be allowed to mature and seed for a few years. Seed is expensive owing to harvesting difficulties. It ripens very unevenly and sheds as soon as it is ripe. This accounts for its high quoted price, which is in the vicinity of 15s. per lb.

Phalaris tuberosa.—This is another perennial grass that makes good growth in the cold weather. Like perennial veldt it has persisted under dry conditions at Wongan Hills for the past three years, but it does not appear to be quite so hardy as that grass. It is best established from seed, which should be sown at 2-3 lbs. per acre in a firm, well prepared seed bed. The young plants are detrimentally affected by competition with weeds, so every care should be taken when establishing to ensure a clean seed bed.

Both this grass and perennial veldt grass may be planted in the autumn.

Government certified seed of Phalaris tuberosa is obtainable at 4s. to 6s. per lb.

For successful results, it is essential that all the smaller seeded species mentioned above, *i.e.*, lucerne, Mexican spinach, perennial veldt grass and Phalaris tuberosa should be planted on a firm, well consolidated seed bed and covered with only a thin layer of soil (about ¼ inch). Rolling with a light roller immediately after seeding is desirable on light soils. For the planting of seeds of this type special pasture seed attachments are obtainable for the drill and are worth purchasing if any large area is to be seeded.

It is sometimes difficult to decide just when to plant summer crops. Most of them require relatively warm conditions for optimum germination. If the land holds its moisture well into the summer it is as well to delay planting until all danger of frosts is over. On the other hand, if it is necessary to rely on rains for germination, it would be advisable to increase the rate of seeding and plant earlier —say early September.

Leguminous crops should be inoculated with the appropriate bacteria before planting.

Heavy dressings of superphosphate (150 lbs. per acre) are essential. On light land half a hundredweight of sulphate of ammonia should also be applied. Commercial fertilisers are available containing superphosphate and sulphate of ammonia in varying proportions. For small areas planted on this type of soil a top dressing of stable manure, even if only a light one, would be well worth while.

The following publications of this Department deal in more detail with several of the matters mentioned above and are available on application:—

No.	Title.
133	Kikuyu Grass.
149	Lucerne.
221	Sudan Grass.
323	Nitrogen-fixing Bacteria.
352	The Sowing of Pasture Seeds.
374	Points in Purchasing Seeds.

THE FRUIT INDUSTRY IN WESTERN AUSTRALIA.

GEO. W. WICKENS,
Superintendent of Horticulture.

AREA AND PRODUCTION.

At the present time when advice is being freely tendered to lessen production by restricting planting as the main method to adopt for preventing the occurrence of glutted markets, it is interesting to turn to records of acreage and production in the fruit industry of Western Australia during the past 20 years. In season 1915-16 the total area under fruit—exclusive of grapes—amounted to 21,805 acres, and in 1934-35 (latest figures available) the area was less by 1,064 acres, having decreased to 20,741 acres. The non-bearing trees in 1915-16 comprised 39 per cent. of the planted area as against 25 per cent. in 1934-35, and the area in bearing is now greater by 2,000 acres, while the average annual production has doubled, but it must be borne in mind that the population of the State increased by 30 per cent. between 1915-16 and 1934-35, with a consequent increase in capacity for fruit consumption.

By far the major portion of the increased production noted in the period under review is represented by apples, the average annual production 20 years ago being 500,000 cases while now it is over 1,000,000 cases. The area under apple trees has undergone considerable change: in 1915-16 it reached 11,894 acres, from then a steady annual decrease took place until 1924-25 when the area was 9,517 acres, a reduction of 2,377 acres in nine years. From 1924-25 onwards there has been a regular annual increase, the area in 1934-35 being 12,449 acres, but still in 19 years the increase only represents 556 acres. The greatly increased production is due to two factors. First, the bearing area was twice as great in the latter season; and, second, the production per tree in many orchards is now much higher than formerly owing to better husbandry practised by growers.

Pears decreased in area from 1,568 acres in 1915-16 to 1,013 acres in 1934-35, and the average annual production is now very little more than it was 20 years ago.

Oranges had practically the same area in 1915-16 as in 1934-35—2,861 acres and 2,864 acres, and it is worthy of note that the reduction in area under orange trees commenced prior to the days when the desirability of restricting planting was strenuously advocated. The peak year for acreage under orange trees occurred in 1922-23 when 3,213 acres were in cultivation. The average annual production is now about 270,000 cases as against 150,000 15 to 20 years ago.

The most notable thing in stone fruit production in the last 20 years is the marked reduction in area under peach trees. In 1915-16 there were 1,420 acres and in 1934-35 the area was reduced to 784 acres.

The area under plum trees was slightly reduced—1,024 acres in 1915-16 and 1,014 acres in 1934-35.

Apricot plantings also suffered a reduction—713 acres in 1915-16 to 673 acres in 1934-35.

The above are the principal orchard fruits grown commercially in Western Australia, and it would seem in the light of the experience of the past 20 years that when for any reason certain kinds of fruit become unprofitable the production of that kind lessens, and the kinds showing profit increase, and this natural ebb and flow in the industry will probably lead to a healthier condition generally than if all planting is suddenly stopped to be followed at some later period, as it surely would be, by a sudden heavy increase.

The area under grape vines has more than doubled in the last 20 years —2,494 acres in 1915-16 and 5,736 acres in 1934-35—and the production has increased from 5,000 tons of grapes annually to 15,000 tons.

Full particulars of acreage and production of all fruits for season 1934-35 are as follow:—

FRUIT PRODUCTION AND ACREAGE FOR SEASON 1934-35.

Orchards.

Kinds of Fruit.	Area. Unproductive.	Area. Productive.	Area. Total.	Yield.	
	acres.	acres.	acres.	Bushels.	
Oranges	408⅞	2,455½	2,864⅜	289,955	
Mandarins	35⅜	148½	183⅞	16,024	
Lemons	70½	419½	490	64,085	
Other Citrus	16⅞	13½	30⅜	1,275	
Apples	3,832⅛	8,617½	12,449⅝	1,228,300	
Pears	144	869¼	1,013¼	103,869	
Quinces	12⅛	69⅞	82	8,033	
Apricots	95¼	577⅞	673⅛	62,760	
Peaches	181⅛	602⅞	784	59,762	
Nectarines	52⅞	145¼	198⅛	17,127	
Plums	233½	781⅝	1,014⅞	77,717	
Cherries	4¾	9⅝	14⅜	18,056	
Almonds	88¾	188½	277¼	70,992	lbs.
Figs	51⅛	287½	338⅝	38,288	
Bananas	98⅜	99⅛	197¾	8,679	bchs.
Other Fruits	38⅝	90⅞	129½	2,890	
Totals	5,364½	15,376⅝	20,741⅛	—	

Vineyards.

	Area.	Production.
Table grapes	962¾ acres	64,271 cwts.
Wine grapes	1,524¾ „	44,824 „
Drying grapes	2,329 „	206,026 „
Non-bearing vines	920 „	..
Total	5,736½ acres	315,121 cwts.

EXPORTS.

Last year a record was made in quantity of fresh fruit shipped overseas with 951,276 cases. This year that record was broken and the State for the first time in its history topped the million case mark with 1,010,920. The new record was made possibe owing to the unusual occurrence of a very heavy apple crop in 1934-35 being followed by an even heavier one in 1935-36, and while some of the extra production this year is due to young trees reaching bearing age, it is a fact that many aged trees in full bearing have cropped heavily in both seasons, and given good weather conditions and freedom from thrips at setting time, full crops can be expected in any season: good cultivation and fertilising being now the rule rather than the exception with the majority of apple growers in the State. The total quantity of apples shipped amounted to 909,308 cases and Great Britain with 619,129 cases absorbed two-thirds. Taking the season as a whole the quality of the apples was very good, but prices in many instances were low on the overseas markets, and growers who sold straight out to agents in Western Australia at an f.o.r. price did considerably better than those who shipped on consignment.

The quantity of pears exported in 1935-36 was greater than in 1934-35—45,785 cases as against 30,060.

Orange export is so small when compared with the crop as to be nearly negligible: last year 3,523 cases were shipped and this year 3,811 cases.

Fresh grapes exported amounted to 50,975 cases, and dried grapes to—currants 1,160 tons, lexias 92 tons.

Full particulars showing quantities of all fresh fruits shipped and destinations are as follow:—

EXPORT OF FRESH FRUIT FROM WESTERN AUSTRALIA TO OVERSEAS PORTS FOR YEAR ENDED 30TH JUNE, 1936.

Destination.	Apples.	Pears.	Grapes.	Oranges.	Plums.	Melons.	Passion Fruit.	Peaches.	Quinces.	Nectarines.	Lemons.	Tomatoes.	Apricots.	Cherries.	Totals.
	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.	cases.
Colombo	4,522	410	23,109	667	61	...	...	10	...	...	9	...	...	7	28,795
Port Said	38,674	100	765	...	...	...	...	...	...	...	...	..	...	...	39,539
Singapore	26,848	421	13,514	1,355	239	2	1	70	...	...	158	...	14	21	42,643
Batavia	4,481	83	2,291	360	54	...	...	...	...	...	...	...	...	...	7,269
Samarang	2,580	38	1,674	200	23	...	...	4	...	...	7	3	2	...	4,531
Sourabaya	4,600	184	1,192	10	124	...	...	3	...	5	...	...	...	...	6,118
Penang	1,145	9	475	17	6	...	...	2	...	3	9	...	1	...	1,667
Port Swettenham ...	2	...	...	2	...	...	...	...	...	...	...	...	...	...	4
Bombay	400	1,419	680	100	...	...	...	...	...	...	...	...	...	...	2,599
Durban	3,392	...	...	...	...	...	...	...	...	...	...	...	...	...	3,392
Mauritius	91	...	...	220	...	...	...	...	...	...	30	...	...	...	341
Madras	100	...	...	...	...	...	...	...	...	...	...	...	...	...	100
Aden	630	...	...	50	...	...	...	...	...	...	...	...	...	...	680
Palembang ...	5	...	...	...	...	...	...	...	...	...	...	...	...	...	5
Malta	605	...	...	...	...	...	...	...	...	...	...	...	...	...	605
Saigon ...	20	100	515	...	...	...	...	...	...	...	...	...	...	...	635
Rangoon	...	...	303	...	...	...	...	...	...	...	...	...	...	...	303
Jaffa	2,570	20	10	...	...	...	...	...	...	...	...	...	...	...	2,600
Haifa	1,412	...	...	...	...	...	...	...	...	...	...	...	...	...	1,412
Telaviv	558	...	...	...	...	...	...	...	...	...	...	...	...	...	558
Jerusalem	400	...	...	...	...	...	...	...	...	...	...	...	...	...	400
Calcutta	20	...	...	...	...	...	...	...	...	...	...	...	...	...	20
London	489,990	37,912	3,553	730	25	...	29½	...	34	...	85	...	...	...	532,358½
Hull	9,628	...	...	...	...	...	...	...	...	...	...	...	...	...	9,628
Southampton ...	17,564	...	500	...	...	...	...	...	...	...	...	...	...	...	18,064
Newcastle	1,300	...	...	...	...	...	...	...	...	...	...	...	...	...	1,300
Glasgow	37,217	...	...	...	...	...	...	...	...	...	...	...	...	...	37,217
Liverpool	63,430	654	...	100	...	...	...	...	...	...	...	...	...	...	64,184
Stockholm	83,768	3,873	1,794	...	...	...	...	...	...	...	...	...	...	...	89,435
Oslo	114	...	...	...	...	...	...	...	...	...	...	...	...	...	114
Hamburg	110,490	562	600	...	...	...	...	...	...	...	...	...	...	...	111,652
Bogen	75	...	...	...	...	...	...	...	...	...	...	...	...	...	75
Rotterdam ...	2,677	...	...	...	...	...	...	...	...	...	...	...	...	...	2,677
Totals ...	909,308	45,785	50,975	3,811	532	2	30½	89	34	8	298	3	17	28	1,910,920½

FRESH FRUIT IMPORTS.

Of fresh fruits imported into Western Australia bananas easily head the list, but with the plantations at Carnarvon rapidly coming into production Western Australia should soon be able to supply its needs in this direction.

Details of all fruits imported both from the Eastern States and overseas are as follow:—

IMPORTATION OF FRESH FRUIT INSPECTED UNDER "THE PLANT DISEASES ACT, 1914," FOR YEAR ENDED 30th JUNE, 1936.

Fremantle:			
Bananas	8,775	crates	
Grape Fruit	53	cases	
Pineapples	905	„	
Custard Apples	15	„	
Nuts	3,045	bags	
Gooseberries	1,012	cases	
Lemons	28	„	
Cherries	543	„	
Mangoes	19	„	
Tomatoes	50	„	
Paw Paws	4	„	
			14,449
Kalgoorlie:			
Bananas	4,853	crates	
Grape Fruit	28	cases	
Pineapples	165	„	
Plums	1,199	„	
Nuts	8	bags	
Pomegranates	8	cases	
Passion Fruit	20	„	
Oranges	1,069	„	
Cocoanuts	5	bags	
Gooseberries	93	cases	
Lemons	331	„	
Cherries	1,332	„	
Persimmons	5	„	
Tomatoes	2,256	„	
Apricots	314	„	
Peaches	1,493	„	
Loquats	11	„	
Nectarines	598	„	
Grapes	5	„	
Mandarins	44	„	
			13,837
Albany:			
Bananas	240	crates	
Grape Fruit	5	cases	
Pineapples	18	„	
Plums	14	„	
Oranges	47	„	
Gooseberries	27	„	
Lemons	4	„	
Cherries	15	„	
Tomatoes	40	„	
Mandarins	8	„	
			418
Total			28,704 packages.

IMPORTATION OF FRESH FRUIT UNDER THE QUARANTINE ACT FOR YEAR ENDING 30th JUNE, 1936.

Bananas (in crates)	2,383,848	lbs.
Bananas (in bunches)	718	„
Pineapples	350	„
Mangoes	50	„
Cocoanuts	54,352	„
Nuts	229,906	„
Total	2,669,224	lbs.

IMPORTATION OF FRUIT TREES AND PLANTS.

The major portion of young fruit trees planted in Western Australia are raised in the Eastern States, and the number imported this year shows a decided falling off in every line in comparison with last year, and it is apparent that planting is slowing down: for instance, apple trees imported in 1934/35 were 25,339, and in 1935/36, 15,269. Orange trees, 1934/35, 19,537; 1935/36, 12,539, and so on through the list.

Details of all kinds of trees and plants imported are as follow:—

"PLANT DISEASES ACT, 1914."

Return of Fruit Trees and Plants Inspected at the Ports of Fremantle and Albany for Year ended 30th June, 1936.

Kind of Trees	Fremantle.	Albany.	Total.
Apple	8,737	6,532	15,269
Apricot	1,758	271	2,029
Almond	1,615	126	1,741
Cherry	583	66	649
Fig	88	10	98
Lemon	3,414	55	3,469
Loquat	844	6	850
Mulberry	33	12	45
Nectarine	1,823	75	1,898
Orange	12,499	40	12,539
Peach	4,996	235	5,231
Persimmon	92	..	92
Pear	2,747	513	3,260
Plum	6,836	472	7,308
Quince	140	12	152
Nuts	1,433	50	1,483
Grape Fruit	987	..	987
Mandarin	596	..	596
Cumquats	61	..	61
Guavas	23	..	23
Ornamental	25,310	874	26,184
Currant	90	125	215
Gooseberry	500	65	565
Loganberry	646	..	646
Raspberry	72	60	132
Bulbs and Roots	179,988	750	180,738
Apple Seedlings	17,000	2,250	19,250
Apricot Seedlings	2,000	..	2,000
Pear Seedlings	3,000	..	3,000
Peach Seedlings	7,136	..	7,136
Orange Seedlings	3,000	..	3,000
Cherry Seedlings	500	..	500
Totals	288,547	12,599	301,146

PESTS AND DISEASES.

In districts where fruit fly has its home it is still the worst enemy the fruitgrower has to contend with, but, fortunately there are still large areas of some of the principal fruitgrowing districts free from the pest, and it is hoped with the money available from the orchard registration to conduct a campaign during the coming season that will bring the pest under control even in the worst infested areas.

The outbreak of Codlin Moth that occurred last year at Collie has been handled so effectively that during the latter part of the season it was not possible to find any larvae either in the fruit or in the bandages around the trees, and it is confidently anticipated that next season's operations will finalise the work of eradication.

By far the most serious invasion by disease this year has been the outbreak of Apple Scab, *Fusicladium dendriticum*, in two important apple districts—one at Manjimup and one at Mount Barker. So far as can be ascertained after most careful search only one orchard in each district is infested and every effort is being made by the growers concerned and departmental officers to stamp out the disease, but the fight is not going to be an easy nor an inexpensive one.

GRADE HERD RECORDING IN WESTERN AUSTRALIA, 1935-36.

G. K. BARON-HAY,
Superintendent of Dairying, Department of Agriculture.

B. WILLIAMS,
Agricultural Adviser.

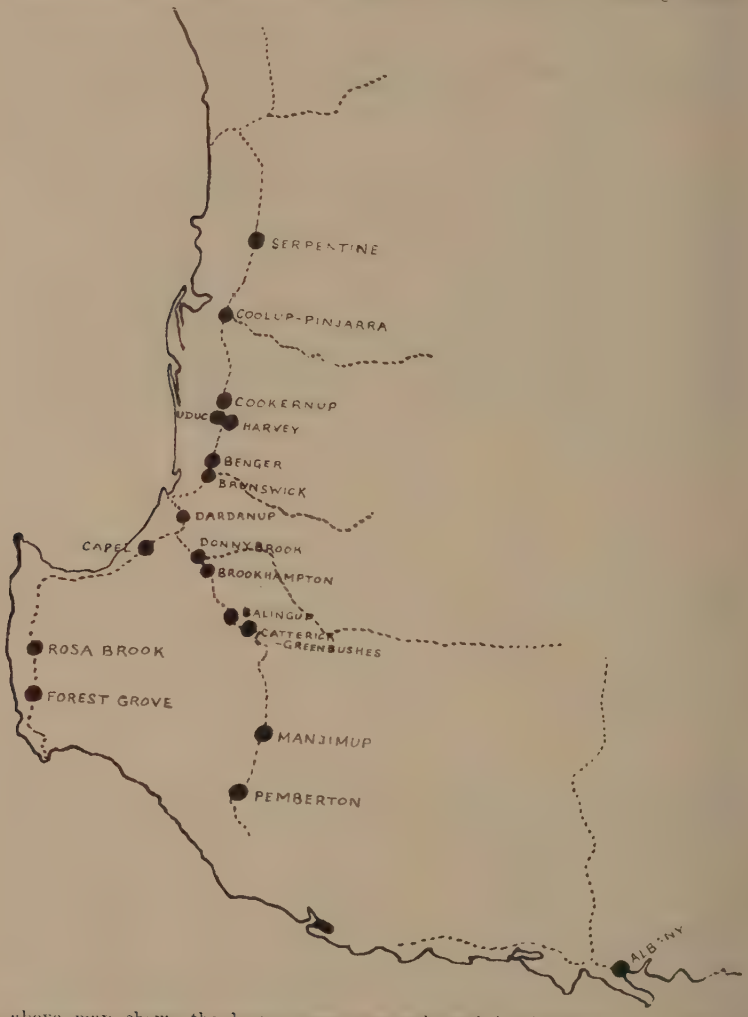
During the three years that Grade Herd Recording has been in operation in this State, farmers have not been slow to recognise the many ways in which the scheme might be of value to them in the conducting of their farming operations.

The results of pasture management have been quickly reflected in the monthly yields; economy can be practised in feeding, by giving the cows rations according to their production; the value of early autumn calving has been demonstrated very forcibly; evidence is beginning to accumulate which will enable those strains or families of pure-bred stock which are prepotent for production of butter-fat to be recognised; the ability to select the calves to be reared only from the higher producing cows; the development of a sense of pride in the industry, and a growing realisation that, to be successful, the business of dairy farming cannot be conducted any longer by rule of thumb methods.

These are a few of the results or effects of the initiation of the scheme, which it must be remembered was instituted at the urgent request of dairy farmers themselves.

There can be no better proof that the scheme is fulfilling an urgent need than the fact that Units have been commenced as fast as funds have been available, and that last May (1936) the number of Units in operation was doubled by the addition of nine new Units, embracing approximately 4,000 cows. There are thus over 8,000 grade cows now under test in Western Australia.

The following map shows the distribution of the 18 Herd Testing Units:—



The above map shows the large areas now embraced in the Grade Herd Recording Scheme.

During the past season conditions generally throughout dairying districts have not been favourable for the growth of pasture, the summer being an unusually dry one. In addition, the rains were light during the growing period in 1935, resulting in the annual clovers being short, and as a result very little silage was cut. The absence of this fodder, and smaller reserves of hay than usual, resulted in the production of butter-fat for the State being slightly below that for the previous year.

In spite of these unfavourable conditions, Table I. shows that the average production of the cows in nine Units has been maintained at 207 lbs. butter-fat per cow.

TABLE 1.—*Average Production per Cow.*

Year.	No. Cows.	Milk Gallons.	Average Test %	Butter-fat Lbs.
1933-34 ..	4,038	415	4.35	180.6
1934-35 ..	4,088	456	4.56	207.8
1935-36 ..	4,590	459	4.51	207.3

It will be noticed that in 1935-36 there was an increase of about 500 cows under test. This was due to a new Unit being commenced at Forest Grove, and its members are to be congratulated on the average production of 206 lbs. in the first year of testing, as this was attained by only one Unit, namely, that at Donnybrook in the first year of recording. (See Table 2.) The average production of 207 lbs. per cow for all Units is rather better than appears at first sight, as one Unit, for reasons mentioned below, averaged only 168 lbs. per cow and was practically a new Unit. The average production of all cows, excluding this Unit, was 217.4 lbs., which, taking into account the season, is a tribute to the management and arrangements made for the conservation of fodder by the farmers concerned.

TABLE 2.—*Average Production of Cows in each Unit.**

Unit.	No. of Herds.	No. of Cows.	Milk. Lbs.	Test. %	Butter-fat (Lbs.). 1935-36.	1934-35.	1933-34.
A. Donnybrook ..	22	370	5,055.0	5.24	265.1	266.8	219.5
B. Serpentine ..	15	408	4,945.5	4.13	204.5	193.1	172.2
C. Cookernup ..	20	468	4,443.8	4.30	191.9	183.5	160.4
D. Harvey ..	22	470	4,641.0	4.63	214.0	205.9	186.4
E. Brunswick ..	19	598	4,773.0	4.55	217.2	206.0	169.2
F. Dardanup ..	24	526	3,951.0	4.25	168.2	192.2	188.6
G. Capel	13	654	4,984.7	4.43	221.1	203.1	182.9
H. Balingup ..	22	547	4,167.0	4.71	196.3	212.4	174.6
I. Forest Grove .	21	368	4,523.0	4.56	206.0	—	—

* Does not include cows under test for less than three months.

A study of Table 2 brings out several interesting points, which are of particular interest to those farmers who are undecided whether to assist in organising a Herd Testing Unit in their district, as indicating some of the results which might reasonably be expected.

It will be noticed that in the first year of testing, all Units, except that of Donnybrook, had an average production per cow considerably below 200 lbs. of butter-fat, the average being (without Donnybrook) only 176 lbs. per cow, and generally speaking, it is believed that this is the average throughout the dairying areas where testing is not being conducted. Donnybrook should not be taken as a representative average district, as at this centre the herds have been graded up to the Jersey breed, generally with good bulls, for a number of years. Culling has been practised for a number of years also, as the herds maintained are not large, mixed farming being practised in most cases.

Table 2 shows that, except in one instance, every Unit has shown a considerable increase since testing began, and that all have either exceeded or are in the neighbourhood of 200 lbs. of butter-fat per cow, which is believed to be the minimum yield that is profitable at present prices. The average production of cows, excluding those at Donnybrook as before, and the Dardanup yields, after three years of testing is 208 lbs. A reasonable expectation should be that the production of a herd should be raised to this figure within three years, irrespective of how low the production is when testing is commenced.

It also will be noticed in Table 2 that the Donnybrook Unit has maintained its production at 265 lbs. butter-fat per cow. The results of testing grade cows seem to show, not only from the above records, but from other records conducted over a much longer period, and with many hundreds of thousands of cows, that it is extremely difficult to maintain herd averages above about 250-260 lbs. of butter-fat, without introducing pure-bred cows, and testing these also with a view to culling out the low producers. Pure bred females, of all ages, produce approximately 330 lbs. per cow, and it is interesting to note that the average of this figure and that of the average cow in the dairy areas (untested), *i.e.*, 180 lbs. per cow, is approximately 255 lbs. It is believed that only by breeding consistently to the one breed of bull, and by the testing of all pure bred cows, can this average of 255 lbs. in commercial herds be increased.

"Devonian Cherry." This cow, owned by Mr. Hull, produced 384 lb butter-fat in 210 days and was the highest producing cow in the Cookernup Unit.

The low results at Dardanup are explained by the fact that this Unit was reorganised during the year, and a large number of cows did not complete their nine months testing period, owing to their having calved late in the season, and owing to the dryness of the season, having to be dried off before completing test

At Balingup also the percentage of cows failing to test for the full period was unusually high, but here not due altogether to late calving but to lack of fodder. The district suffered severely from fires, and a number of farmers in the Unit were forced to feed their conserved hay or silage earlier than usual and—later in the summer—ran out of supplies.

The experience of farmers in all districts during the last summer has stressed the fact that early autumn calving of cows is to be recommended, so that green feed may be available during as much as possible of the lactation period. Investigations

into the records of Grade Herd Recording during the first two years indicate that increased yields of from 18 per cent. to 25 per cent. may be expected from cows which calve during May, in comparison with cows calving after August. This variation will be greatest, of course, in low rainfall areas where the spring is shorter and the summer correspondingly longer.

TABLE 3.—*Percentage of Cows Completing Nine Months Test.*

Unit.	Per Cent.	Av. Butter-fat. lbs.
Donnybrook	88.5	265.1
Capel	73.2	221.1
Brunswick	62.2	217.2
Harvey	44.2	214.0
Forest Grove	63.8	206.0
Serpentine	70.5	204.5
Balingup	43.6	196.3
Cookernup	24.1	191.9
Dardanup	20.7	168.2

"Meg." Grade Guernsey. Production 436 lb. butter-fat in 273 days. Owned by Mr. A. F. Dean, of Brunswick.

In Table 3 the Units are arranged in order of their average production, and it will be noticed that generally the production varies with the percentage of cows completing their test, which are also those which have most cows calving early in autumn.

The influence of irrigation is seen in particular in the Harvey Unit and also in the Brunswick Unit, which are higher up the list than one would expect from the number of cows completing test. In both these Units a large percentage of the farmers testing are suppliers of whole milk and, therefore, are forced to maintain

a continuous flow of milk, which necessitates the calving of some cows every month of the year. Without irrigation, such a practice certainly would result in a very decreased production unless special steps were taken to provide silage or summer crops, which is an added cost to production, in comparison with calving early in the autumn, and allowing the cows to eat their own feed from the paddocks.

In order that the information supplied by the Herd Recorder each month may be utilised by the individual farmer, more detailed information than that given in Table 2 is required, and calls for a thorough knowledge of each individual cow in the herd, in order that feeding according to production may be practised and the elimination of unprofitable cows will be commenced.

The standard adopted by farmers in culling their herds depends on a number of factors involving the cost of feeding, the market which is available for milk—whether this be for whole milk, cheese, condensed milk, or butter-fat, and particularly the average production of the herd itself. Farmers owning low producing herds would be required, by necessity, to retain cows in their herds which certainly would be culled from higher producing Units. The necessity for this is shown in Table 4 where the production of the three leading herds in each Unit is compared with that of the three lowest producing herds.

TABLE 4.—*Production of the Leading Three Herds in each Unit compared with the production of the Lowest Three Herds.*

Unit.		No. Cows tested.	Average Yield of Milk. lbs.	Average Yield of Butter-fat. 1935-36. lbs.	1934-5. lbs.
Donnybrook	1	57	6,451.0	351.01	334.4
	2	43	4,082.0	196.60	187.4
Serpentine	1	66	6,175.9	283.74	254.8
	2	62	3,442.0	147.59	145.2
Cookernup	1	88	5,504.8	250.05	231.5
	2	44	3,484.7	139.60	139.9
Harvey	1	55	6,275.1	294.81	272.3
	2	89	3,178.4	143.63	138.1
Brunswick	1	103	5,938.4	269.54	245.4
	2	74	3,552.0	166.63	156.6
Dardanup	1	67	5,201.0	244.77	252.9
	2	72	3,526.0	168.32	151.8
Capel	1	101	6,452.2	287.38	251.7
	2	174	3,884.6	178.57	160.6
Balingup	1	91	5,872.3	270.50	269.1
	2	84	3,126.0	138.28	182.2
Forest Grove	1	50	6,105.0	286.59	—
	2	49	3,353.0	144.79	—

1.—Average production of the three high producing herds.
2.—Average production of the three low producing herds.

It is interesting to notice in Table 4 that the average production of the three leading herds is considerably higher than was the case the previous year, 1934-35. While, however, there is the same tendency for the low producing herds to show an improvement, it is surprising that a greater increase has not been registered by these lower herds. It would appear that farmers with good herds are those who are fully seized with the importance of careful feeding, conservation of fodder, herd management, and the necessity of culling. It, however, should be possible for lower producing herds to show greater relative increase than herds of higher capacity.

An outstanding example of what can be accomplished by culling and good dairy husbandry is that of Mr. D. D. Johnstone in the Harvey Unit. At the end of the first year of testing, Mr. Johnstone's herd of 14 cows averaged 157 lb. butter-fat. He courageously disposed of the whole of this herd and purchased tested cows from farmers in the Donnybrook Unit. Last year the average production of the herd of 19 cows was 302.9 lb. butter-fat. It is not inferred that this system of culling is practicable in all cases, but the possible value of studying the individual records is clearly shown.

Another example is the improvement which has been effected in the herd owned by the late Dr. S. C. Joel at Elgin and controlled by Mr. Busquet. At the end of 1934 this herd, comprising 155 cows, had an average production of only 124 lb. butter-fat per cow. Within two years, by heavy culling, Mr. Busquet was able to increase the production from 150 cows to no less than 215 lb. butter-fat per cow. In this case, the increase has been almost entirely due to improved quality amongst the cows, as strict attention has always been paid to an adequate provision of fodder throughout the year.

"Eva." The property of Mr. F. Byrd, whose herd gained the highest average butter-fat production in the Harvey Unit with 307 lb. butter-fat.

A further point of interest in Table 4 is that, except in the case of the Donnybrook unit, the leading three herds of which have the particularly high average of 351 lb. butter-fat per cow, the productions of the leading herds in other units approximates to the figure which has been mentioned previously as that most difficult to improve upon in typical grade herds *i.e.* 250-270 lb. butter-fat. There is no reason why all herds should not approach this level of production in the near future.

A further dissection of the results is shown in Table 5, which sets out the highest producing cow in each unit, the owners of which are the winners of the various trophies which have been presented with the view of stimulating interest in production, particularly in the special requirements of those cows with a capacity far above the average.

The rules governing the winning of these trophies are as follow:—

1. The trophy shall be held for one year by the owner of the cow producing the greatest quantity of butter-fat and completing her lactation period during the testing year.

Where cows complete their lactation period during April in any year, the production for April shall be calculated by multiplying the March production by .9 and taking a sub-period of 33 days.

2. Such cow to be eligible for the competition shall be at least five months pregnant at the end of the lactation period.

3. A replica of the cup will be given to the winner each year, and will be held permanently by him.

4. The competition will be conducted for five years, the farmer obtaining the greatest number of successes during this period becoming the permanent owner of the trophy.

In the event of a different farmer winning each year, the owner of the highest-producing cow will retain the trophy.

TABLE 5.—*Highest Producing Cow in each Unit.*

	Milk (lbs.).	Test %	Butter-fat (lbs.)
Donnybrook Unit—			
(Cup presented by Boyanup Dairy Co.)			
L. C. Field—"Winkie" J.	8,424	6.0	503.25
Serpentine Unit—			
(Cup presented by Serpentine Co-operative Cheese Factory, Ltd.)			
S. F. Russell—"Jennie" A.G.	11,511	4.87	561.53
Cookernup Unit—			
(Cup presented by Hon. Hobart Tuckey, M.L.C.)			
W. Hull—"Cherry"	7,305	5.2	384.6*
Brunswick Unit—			
(Cup presented by Browne's, Ltd.)			
Ellis Bros.—"Jinny" Gr.J.	10,010	5.3	530.9*
Dardanup Unit—			
(Cup presented by Hon. Leslie Craig, M.L.C.)			
C. Gilmour—"Seven" Gr.J.	9,030	5.03	455.01
Capel Unit—			
("Summerlea" Cup presented by Messrs. Dunkley Bros.)			
T. Jamieson—"Pickles" S.Hx.J. ..	10,284	5.3	563.58
Balingup Unit—			
(Cup presented by Manjimup Dairy Produce Co., Ltd.)			
S. C. Maidment—"Buttercup" Gr.J. ..	8,994	5.05	454.24
Forest Grove Unit—			
H. Eddy—"Beauty" Gr.J.	8,335.5	5.3	442.37

*210 days.

In Table 6 below herds are grouped according to production of butter-fat, and a comparison of the number of herds in each group during the three years for which records are available shows a definite trend towards the reduction of unprofitable herds, and a larger number appearing in those groups which are considered profitable, namely, above 200 lb. butter-fat per cow.

TABLE 6.—*Herds Grouped According to Production.*

(Herds tested less than 273 days omitted.)

Unit.	No. Herds.	Pounds of Butter-fat Per Head. 350-400.	300-350.	250-300.	200-250	150-200	100-150.
Donnybrook ..	22	1	4	7	8	2	—
Serpentine ..	15	—	1	2	4	6	2
Cookernup ..	20	—	—	2	5	11	2
Harvey ..	22	—	2	4	7	7	2
Brunswick ..	17	—	—	4	6	7	—
Dardanup ..	12	—	—	1	6	5	—
Capel ..	13	—	—	6	2	5	—
Balingup ..	22	—	—	4	6	8	4
Forest Grove ..	20	—	1	3	5	8	3
Totals ..	163	1	8	33	49	59	13
Per cent. 1935-36	—	0.6	4.8	19.9	29.5	37.4	7.8
Per cent. 1934-35	—	—	3.5	15.5	34.5	41.5	5.0
Per cent. 1933-34	—	—	1.3	3.9	20.3	53.6	20.9

"Cherry." A high producing Jersey owned by Mrs. A. Eckersley, of Harvey. Production 511 lb. butter-fat as a three-year-old.

It will be seen that the number of herds in the lowest group namely, 100-150 lb. butter-fat, is only one-third as many as was the case three years ago.

There are also five times as many herds in the 250-300 lb. group as when Grade Herd Recording was initiated.

Last year 55 per cent. of the herds under test reached a profitable level of production in comparison with only 25 per cent. during the first year of testing.

The improvement which has been effected is not only a vindication of Grade Herd Recording, but demonstrates very clearly that dairy farmers have appreciated the commercial value of the information available, and—which is more important—have acted on the information supplied.

The extent to which the elimination of unprofitable cows is being practised is shown in Table 7, where it will be seen in the last column that 424 cows were culled during the year in comparison with 287 during 1934-35.

There is no doubt that culling during 1934-35 was a potent factor in improving production averages during the past season, and, in view of the percentage of cows which have been culled, namely, 11.5 per cent. during 1935-36, it is confidently expected that there will be a still further increase in production during the coming year.

CONCRETE CIRCULAR WATER TROUGH.
Note the sturdy construction and cross rails. This photograph was taken on Mr. D. D. Johnstone's property at Harvey.

TABLE 7.—*Cows in each Unit grouped according to Production.*

Unit.	No. Cows.	Average Butter-fat (lbs.) per Cow. Over 500 lbs.	400-500.	300-400.	200-300.	150-200.	100-150.	Culled.
Donnybrook ..	381	1	14	85	181	56	14	11
Serpentine ..	506	1	5	49	156	110	51	134
Cookernup ..	454	..	..	23	174	112	102	43
Harvey ..	470	1	6	50	180	125	68	40
Brunswick ..	598	..	6	78	246	161	86	21
Dardanup ..	526	..	2	21	184	122	149	48
Capel ..	654	1	6	71	284	170	122	..
Balingup ..	605	..	2	44	185	158	117	99
Forest Grove ..	396	..	7	32	162	105	62	28
Totals ..	4,590	4	48	453	1,762	1,119	671	424
Per cent. 1935-36 ..		.01	1.05	10.0	38.4	24.4	14.6	11.54
do. 1934-35 ..		.1	1.1	9.8	36.7	25.5	19.8	7.0
do. 1933-34 ..		.05	.45	4.15	30.19	29.54	26.42	9.2

From the fact that 55 per cent. of the herds under test exceeded 200 lb. butter-fat per cow, but only 49 per cent. of the individual cows exceeded this production, it will be seen that, even in the highest producing herds, there are a number of cows which are definitely unprofitable producers.

It will be noted from the average productions over the three years—shown at the bottom of Table 7—that an increasing percentage of cows attained the profitable level of over 200 lb. butter-fat each year and that, as these higher productions are reached, farmers are still striving for further improvement as is shown by the increasing number of cows "culled" each year.

Rule 6 governing the operation of Grade Herd Recording in Western Australia requires that, within five years from the inception of the scheme, the bulls owned by members of the Association shall all be pure bred and, if possible, from cows of known production. Table 8 shows the degree to which this rule is being observed and indicates that members are fully aware of the advantages accruing to the use of pure bred bulls.

TABLE 8.—*Percentage of Pure-Bred Bulls in each Unit according to Breed.*

Unit.	No. Herds.	% P.B. Bulls.	Jersey.	Guernsey.	A.I.S.	Fresian.	Ayrshire.	Red Poll.
Donnybrook	22	90.5	86	—	4.5	—	—	- -
Serpentine	15	93.4	26.7	20.0	20.0	26.7	—	—
Cookernup	20	95.0	10.0	30.0	45.0	5.0	—	5.0
Harvey	22	77.3	45.5	9.1	18.2	4.5	—	—
Brunswick	19	100	36.8	5.3	57.9	—	—	—
Dardanup	24	58.3	37.5	4.2	8.3	4.2	—	4.2
Capel	13	93.3	36.6	—	33.3	6.6	16.6	—
Balingup	22	88.4	57.7	7.7	23.0	—	—	—
Forest Grove	21	90.5	90.5	—	—	—	—	—
Total Percentages—								
1935-36		87.4	54.4	9.6	26.8	5.9	2.1	1.2
1934-35		84.2	47.7	8.2	31.3	7.6	3.7	1.5
1933-34		69.7	52.2	2.6	31.3	7.9	4.3	1.7

Of particular interest in Table 8 is the comparison between the percentage of these desirable sires in 1934 with that in the year 1936. In 1934 the percentage of pure bred bulls was 69.7, while in 1936 the percentage had risen to 87.4, and in one Unit, namely, the Brunswick Unit all members owned pure bred sires.

It will be seen also that those breeds from which bulls are available ex tested dams predominate, namely, Jersey, Illawarra Shorthorn, and Guernsey breeds, and that there is a tendency for the increase in those breeds which exhibit a high butter-fat percentage in their milk.

Table 9 below shows cows grouped according to age and production, and from this table the comparative rarity of grade cows testing over 300 lb. butter-fat is well shown.

TABLE 9.—*Cows grouped according to Age and Production. All cows in milk less than 100 days not included.*

Age Class*	Groups according to Butter-fat Production: Over 500 lbs.	400-500.	300-400.	200-300.	150-200.	100-150.	Total Cows.
Mature	4	44	395	1,170	526	284	2,423
Three years	..	7	38	218	208	118	589
Senior 2 years	..	1	16	140	106	87	350
Junior 2 years	..	..	2	162	218	169	551
Totals ..	4	52	451	1,690	1,058	658	3,913
Per cent. ..	0.1	1.3	11.6	43.2	27.0	16.8	100.0

* Age at commencement of lactation.

Of the 3,913 cows tested over three months, only approximately 12 per cent. exceeded 300 lb. butter-fat, while only 1.3 per cent. produced over 400 lb. butter-fat per cow. From these figures it will be realised that a very severe standard is set under the Pure Breeds Herd Recording Rules before a Production Certificate is issued to a mature cow. This standard is no less than 350 lb. butter-fat to be produced in nine months, while the standard for junior heifers calving under $2\frac{1}{2}$ years of age is not less than 230 lb. to be produced in nine months. This is one reason why the average production of pure bred cows is approximately 75 lb. greater than that of grade cows which have been tested for some years, but it will be noticed that this higher production has been attained by the same principle as is in operation for improving yields in commercial herds, namely, the testing of these pure bred cows and the discouraging of breeding from those which do not attain a reasonable production standard.

A glimpse of Mr. A. Millar's property at Forrest Grove. The pasture, it will be noted, is short owing to the unfavourable season experienced.

Pedigree alone does not infer production, and it is to the credit of stud breeders that this is fully realised by them, and that every effort is made to raise the status of pedigree cows by submitting them to test wherever possible, and also publishing the results obtained—whether good or ill. From this also it will be realised that one of the surest methods of increasing average production in commercial herds is by the use of pure bred sires ex cows to which production certificates have been awarded. A study of the individual records indicates the soundness of the policy of the use of such sires, which has now been actively adopted by dairy farmers for 10 years.

Even in the herds now under test, which are rather above the average in production, it is found that 82 per cent. of the young cows which calved under three years of age—after making due allowances—exceeded the standard of 200 lb. butter-fat, while only 62 per cent. of the mature cows did so. This indicates that the young stock being reared are of higher producing capacity than the average mature cows from which they are descended.

To still further encourage the rearing of heifers from only the highest producing cows, a Calf Marking Scheme has been initiated whereby the calves from all cows producing over 250 lbs. butter-fat in nine consecutive months will be iden-

tified by a tattoo brand in the left ear. A fee of 2s. is made for each calf marked and which covers the cost of a certificate showing the breeding of the calf and the production of the dam, which is issued to the owner.

As a further incentive to dairy farmers to study the effect of giving adequate attention to those cows of special capacity in the herds, the Directors of the South-West Co-operative Dairy Farmers Ltd. have presented a valuable cup to be competed for amongst members of Grade Herd Recording Units throughout the South-West and is to be held for one year by the owner of the four highest producing cows. The cup is for perpetual competition, a replica being given each year to the successful owner.

Mr. S. F. Russell, of Serpentine, has won this trophy for the 1935-36 season, his four cows which are shown below having an average production of 465.37 lb. butter-fat.

It may be said that Mr. Russell is able to feed his cows specially well, as the bulk of the milk is sold for consumption as whole milk, and that, if he were producing butter-fat only, feeding on the scale practised by Mr. Russell would not be profitable. Those who argue along these lines should visit his farm and they will be convinced that probably on no other farm throughout the dairying districts is there a greater conservation of fodder practised or greater care for the provision of succulent feed during summer months. At the end of July this year, the writer saw maize eight feet high still standing in the field on this farm. It is believed that, if the same conservation of fodder is practised on dairy farms for the feeding of stock, farmers would be surprised—as was Mr. Russell—at the high average production which would be achieved by their herds.

The following are the individual records of Mr. Russell's four cows:—

Name of Cow.	Milk (lb.).	Butter-fat (lb.).
Jennie	11,511	561.53
Darkie	11,412	463.52
Dimple	9,162	425.63
Bishop	8,598	410.79
Average	10,171	465.37

"Bishop," owned by Mr. S. F. Russell, of Serpentine, which produced 442 lb. butter-fat in 273 days.

Table 10 shows the names of the owners of the leading three herds in each Unit, and Tables 11-19 the average production of each herd tested in each Unit during the year 1935-36.

TABLE 10.—*Leading Three Herds in each Unit.*

Unit.	No. cows.	Bull.	Milk (lbs.).	Test %	Fat (lbs.).	Owner.
A. Donnybrook ..	10	J.	7,202	5.4	391.03	L. C. Field
	20	J.	6,271	5.3	333.90	A. Trigwell
	18	J.	5,932	5.4	325.18	D. Foan
B. Serpentine ..	20	G.	7,876	3.9	313.38	D. L. Jones
	23	G.	6,147	4.6	286.55	S. F. Russell
	23	J.	4,857	5.3	256.02	E. M. Rose
C. Cookernup ..	19	G.	5,208	5.0	260.65	A. R. Testar
	26	G.	5,698	4.3	250.30	E. Marston
	43	A.I.S.	5,609	4.2	239.20	C. A. Wickham
D. Harvey ..	22	F.	7,626	4.2	307.52	F. Byrd
	19	J.	5,696	5.3	302.86	D. D. Johnstone
	14	J.	5,503	4.9	274.04	A. G. Eckersley
E. Brunswick ..	34	A.I.S.	6,247	4.4	276.79	Ellis Bros.
	31	G.	5,624	5.2	273.18	A. F. Dean
	38	A.I.S.	6,212	4.2	260.18	A. S. Warburton
F. Dardanup ..	24	Gr.J.	5,556	4.7	266.66	C. Gilmour
	22	J.	4,753	5.0	237.89	B. Panizza
	21	Gr.J.	5,267	4.3	226.87	J. M. Gardiner
G. Capel ..	28	A.I.S.	7,172	4.1	295.31	T. Jamieson
	44	J.	5,974	4.9	293.79	C. A. McCormack
	29	A.	6,482	4.2	269.96	D. Farley
H. Balingup ..	25	A.I.S.	6,246	4.5	279.20	S. C. Maidment
	27	J.	5,275	5.3	278.81	A. Tomerini
	39	A.I.S.	6,096	4.1	253.50	A. Brazier
I. Forest Grove ..	16	J.	6,804	4.9	338.36	H. Eddy
	19	J.	5,761	4.6	262.65	H. L. Holland
	15	J.	5,797	4.5	261.72	T. A. Fenning

Mr. A. F. Dean's grade Guernsey "Blossom," which produced 459 lb. butter-fat in 273 days. Tested in the Brunswick Unit.

TABLE 11.—DONNYBROOK (UNIT "A")—HERD RECORDER: P. T. WYLLIE.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
L. C. Field	19	7,134	5.5	393.52
A. Trigwell	20	6,271	5.3	333.90
O. Foan	18	5,932	5.4	325.18
Herd "C"	15	5,730	5.5	317.13
„ "H"	17	5,735	5.49	316.29
„ "Z"	24	6,056	5.1	313.77
„ "A"	32	5,482	5.1	279.88
„ "AI"	10	4,966	5.4	270.59
„ "AO"	22	4,848	5.5	268.19
„ "W"	9	4,527	5.5	253.07
„ "X"	18	4,662	5.3	250.79
„ "K"	19	4,433	5.4	241.87
„ "E"	20	4,908	4.9	241.10
„ "N"	12	4,500	5.3	239.98
„ "D"	24	5,232	4.5	239.73
„ "I"	10	4,394	5.3	234.20
„ "A2"	15	4,147	5.2	218.39
„ "Q"	16	4,696	4.6	216.92
„ "F"	23	4,070	5.1	208.91
„ "A"*	17	4,202	5.0	201.50
„ "B"*	16	3,636	5.4	198.76
„ "M"	10	3,594	5.1	184.85

* Letter reversed.

TABLE 12.—SERPENTINE (UNIT "B")—HERD RECORDER; A. R. POWELL.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
D L. Jones	20	7,876.10	3.98	313.38
S. F. Russell	23	6,146.91	4.66	286.55
E. M. Rose	23	4,856.90	5.27	256.02
Herd "U"	17	5,950.40	3.86	229.63
„ "T"	39	6,009.00	3.61	217.07
„ "Q"	26	5,353.00	3.95	211.93
„ "S"	20	5,935.45	3.53	209.62
„ "B"	24	5,013.40	3.96	198.73
„ "I"	28	4,931.25	3.94	194.29
„ "A"	70	4,437.20	4.30	191.15
„ "R"	20	4,346.70	4.15	180.55
„ "W"	38	3,800.10	4.36	165.70
„ "C"	24	3,767.30	4.39	165.48
„ "P"	28	3,326.30	4.10	136.62
„ "N"	10	2,985.30	4.53	135.31

TABLE 13.—COOKERNUP (UNIT "C")—HERD RECORDER: E. KER.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
A. R. Testar	19	5,207.8	5.04	260.65
E. Marston	26	5,697.7	4.30	250.30
C. A. Wickham	43	5,609.1	4.20	239.20
Herd "3C"	21	4,557.5	4.9	227.06
„ "A"	9	5,191.7	3.9	209.40
„ "Q"	26	4,579.6	4.5	206.80
„ "H"	11	4,499.7	4.5	204.90
„ "B"	33	4,813.1	4.08	196.80
„ "L"	26	4,681.3	4.10	194.70
„ "J"	36	5,747.7	3.30	194.10
„ "7C"	35	4,388.5	4.4	193.50
„ "T"	18	4,085.8	4.6	188.11
„ "P"	22	3,748.0	4.6	174.50
„ "1C"	30	4,156.1	4.1	172.14
„ "N"	9	4,010.4	4.2	170.75
„ "CA"*	20	3,453.0	4.9	170.50
„ "CB"*	40	4,095.4	4.4	165.70
„ "W"	22	3,776.6	4.03	153.50
„ "2C"	11	3,558.6	3.90	140.44
„ "X"	11	3,119.0	4.01	124.96

* Letters "A" and "B" reversed.

TABLE 14.—HARVEY (UNIT "D")—HERD RECORDER: J. MORGAN.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
F. Byrd	22	7,626.0	4.20	307.52
D. D. Johnstone	19	5,696.3	5.30	302.86
A. G. Eckersley	14	5,503.0	4.90	274.04
Herd "N"	23	5,287.2	5.20	274.00
„ "AC"	8	5,141.9	5.40	272.00
„ "R"	19	6,162.8	3.98	252.23
„ "G"	23	5,052.3	4.59	234.63
„ "O"	29	4,680.2	4.96	231.20
„ "AF"	26	4,958.2	4.65	230.60
„ "B"	16	4,719.1	4.70	217.28
„ "E"	19	4,372.0	4.80	205.96
„ "C"	20	3,885.4	5.18	204.39
„ "AG"	13	4,713.3	4.47	200.50
„ "I"	19	3,985.2	4.92	196.62
„ "AH"	11	4,799.7	3.90	190.52
„ "A"	29	3,796.9	4.79	182.76
„ "P"	27	4,275.5	4.04	171.12
„ "W"	23	4,444.8	3.69	168.10
„ "AD"	21	3,507.2	4.64	161.65
„ "K"	19	3,031.5	5.08	154.32
„ "J"	18	3,463.5	4.13	143.59
„ "V"	52	3,040.1	4.38	132.99

TABLE 15.—BRUNSWICK (UNIT "E")—HERD RECORDER: S. A. HARDY.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
Ellis Bros.	34	6,247	4.43	276.79
A. F. Dean	31	5,264	5.19	273.18
A. S. Warburton	38	6,212	4.18	260.18
Herd "V"	46	5,852	4.36	255.20
„ "H"	31	5,556	4.36	245.18
„ "U"	51	4,923	4.81	236.86
„ "J"	44	5,156	4.26	219.57
„ "E"*	21	5,128	4.14	212.39
„ "D"*	25	4,306	4.71	203.00
„ "G"*	34	4,047	4.99	201.98
„ "A"	41	4,860	4.11	199.85
„ "F"*	38	4,358	4.58	199.47
„ "Q"	20	3,970	4.80	190.52
„ "B"*	70	3,759	4.92	185.10
„ "A"*	26	3,525	5.17	182.40
„ "S"	22	3,948	4.32	170.74†
„ "R"	22	3,852	4.19	161.68†
„ "G"*	15	3,618	4.43	160.48
„ "E"	33	3,544	4.32	153.30

* Letter reversed. † Tested eight months only.

"Jennie," which produced 561 lb. butter-fat in 273 days and was the winning cow in the Serpentine Unit. Owned by Mr. S. F. Russell.

TABLE 16.—DARDANUP (UNIT "F")—HERD RECORDER: A. P. DEVLIN.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
C. Gilmour	24	5,556	4.7	266.66
B. Panizza	22	4,753	5.0	237.89
J. M. Gardiner	21	5,267	4.3	226.87
Herd "E"*	32	5,782	3.9	226.67
" "L"*	23	4,535	4.9	223.88†
" "W"	11	4,815	4.6	222.98
" "D"*	17	4,879	4.5	221.31
" "F"*	17	4,151	5.0	207.53
" "A"	50	3,516	5.2	183.96†
" "C"*	10	3,511	5.1	180.78
" "6"	20	3,640	4.9	179.09‡
" "K"	41	4,551	3.9	178.96
" "I"	19	3,263	5.3	173.83
" "A"*	24	3,846	4.3	167.41
" "N"	29	3,468	4.7	165.47
" "J"*	29	3,409	4.7	162.14§
" "J"	18	3,431	4.7	161.38‡
" "K"*	11	3,228	5.0	157.67†
" "G"*	26	3,392	4.4	150.09‡
" "Q"*	34	3,041	4.6	142.23§
" "P"*	14	2,910	4.4	127.94§
" "O"	10	2,875	4.1	117.99§
" "B"*	10	2,051	4.6	95.53†
" "R"*	14	2,241	3.9	88.31‡

* Letter reversed. † Tested eight months. ‡ Tested seven months.
§ Tested six months.

TABLE 17.—CAPEL (UNIT "G")—HERD RECORDER: R. R. RUTHERFORD.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
T. Jamieson	28	7,172.2	4.12	295.31
C. A. McCormack	44	5,974.1	4.91	293.79
D. Farley	29	6,482.3	4.16	269.96
Herd "W"	15	6,350.7	4.05	256.39
" "A"	71	5,415.8	4.72	255.74
" "N"	27	6,532.2	3.86	252.15
" "L"	150	4,742.7	4.55	214.77
" "E"	38	4,936.4	4.31	212.98
" "H"	48	4,856.7	4.08	198.05
" "G"	30	4,791.9	4.10	196.61
" "X"	37	4,215.4	3.99	180.08
" "J"	40	3,870.2	4.62	179.79
" "I"	97	3,661.2	4.84	177.78

TABLE 18.—BALINGUP (UNIT "H")—HERD RECORDER: A. M. TINDALE.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
S. C. Maidment	25	6,245.6	4.47	279.20
A. Tomerini	27	5,275.0	5.28	278.81
A. Brazier	39	6,096.5	4.15	253.50
Herd "L"	17	5,350.7	4.69	251.06
„ "V"	26	5,058.3	4.67	236.66
„ "N"	22	4,611.8	5.02	231.83
„ "P"	22	4,886.7	4.72	231.80
„ "R"	12	4,683.1	4.86	227.87
„ "A"	6	4,752.0	4.41	209.94
„ "H9"	18	3,974.1	5.19	206.51
„ "H3"	20	3,516.1	5.49	193.28
„ "K"	36	3,769.0	4.94	186.32
„ "H8"	30	3,944.7	4.62	182.27
„ "H5"	26	3,985.0	4.18	166.73
„ "Q"	11	3,559.3	4.63	165.14
„ "C"	38	3,320.3	4.66	155.04
„ "H2"	30	3,453.8	4.40	152.15
„ "H1"	36	2,974.8	5.04	150.08
„ "H4"	20	2,841.1	5.15	146.48
„ "M"	31	3,083.2	4.64	143.18
„ "H6"	33	3,070.9	4.48	137.73
„ "H7"	22	3,224.0	4.15	133.94

"May." Friesan-Jersey crossbred owned by Mrs. A. Eckersly, of Harvey. Production 502 lb. butter-fat in 273 days. This was the first cow to produce over 500 lb. butter-fat in the Harvey Unit.

TABLE 19.—FOREST GROVE (UNIT "I")—HERD RECORDER: C. R. DIXON.

Owner.	No. of Cows.	Average Milk per Cow.	Average Test.	Butter-fat per Cow.
		lb.	%	lb.
H. Eddy	16	6,804	4.97	338.36
H. L. Holland	19	5,761	4.56	262.65
T. A. Fenning	15	5,797	4.52	261.72
Herd "G"	38	5,384	4.75	255.49
„ "F"	20	4,969	4.80	238.29
„ "Y"	22	4,379	4.88	213.84
„ "P"	17	4,612	4.58	211.31
„ "D"	25	4,624	4.40	203.79
„ "X"	21	4,563	4.32	200.89
„ "R"	20	4,898	4.40	193.37
„ "L"	24	3,959	4.87	192.99
„ "B"	17	4,353	4.21	183.92
„ "E"	19	3,939	4.65	183.28
„ "O"	15	4,350	4.17	181.47
„ "T"	18	3,974	4.45	176.71
„ "S"	19	4,063	4.07	165.16
„ "Q"	16	3,412	4.74	161.72
„ "W"	14	3,299	4.35	149.69
„ "A"	18	3,387	4.39	143.25
„ "C"	17	3,360	4.24	142.33
„ "Z"	12	2,864	4.43	126.94*

* Tested six months only.

"DE-HORNED CATTLE ARE QUIET."

This fine herd, owned by Mr. D. D. Johnstone, of Harvey, averaged 302 lb. butter-fat for the 1935-36 season.

IMPERMEABLE SEEDS OF "DWALGANUP" SUBTERRANEAN CLOVER.

G. R. W. MEADLY,
Assistant Botanist.

The presence of so-called "hard seeds" in commercial seeds of leguminous plants is a condition which has received consideration in all parts of the world. These "hard seeds" appear in every way identical with the normal type, even when examined microscopically, but differ fundamentally in the fact that they do not readily absorb water and germinate.

The degree of impermeability varies for different species and also in different samples of the same species. Storage conditions of temperature and humidity as shown by Esdorn and Steutz (1) have a decided effect on the degree of impermeability, particularly in the case of yellow and blue lupins, lucerne and red clover. Under similar conditions white clover and Alsike were relatively stable. Bredemann (2) also stresses the relationship between the degree of impermeability and the temperature and moisture of the storeroom. He states that hard seededness is a reversible process and fluctuates with the periodical fluctuations of the weather.

The structural cause of impermeability to water has been investigated with various seeds and Lute (3) has demonstrated that in the case of lucerne (*Medicago sativa* Linn.) the water intake is governed by the palisade layer comprising the testa or seed coat. Paring away of the cuticle produced no effect on the rate of water intake but when the tips of the palisade cells were injured the seeds took up water rapidly, swelling occurring in a few seconds. Behrens (4) arrived at the same conclusion with various other legumes after examining the seed coat under lowered pressure.

VALUE OF "HARD SEEDS."

One might readily question the significance of "hard seeds" in commercial lines. They have disadvantages as well as advantages. If early rains are followed by a severe dry period seedlings produced from readily germinating seeds are killed, but the presence of "hard seeds" which germinate at intervals under favourable conditions will frequently produce a useful stand. When the survival of annual clovers or other leguminous crops depends upon natural "seeding down" each year the "hard seed" content is of decided value. In the initial sowing, however, when the time of seeding can be regulated according to the conditions, the value of "hard seeds" is reduced, particularly when present in excessive quantities, for example 90 per cent. or more as is frequently the case with drooping-flowered clover (*Trifolium cernuum* Brot.). In Western Australia the "hard seed" content of commercial seeds is an item of considerable moment. Most of our imports, such as red clover, white clover and lucerne, give little concern, but a number of leguminous seeds produced locally have an appreciable impermeable content. This is most pronounced in drooping-flowered clover, as mentioned above, but is also experienced in cluster clover (*Trifolium glomeratum* Linn.), blue lupin (*Lupinus varius* Linn.) and subterranean clover (*Trifolium subterraneum* Linn.). Several strains of subterranean clover occur in this State and seed of two, viz., midseason and Dwalganup (Extra early) is produced commercially. The "hard seed" content of commercial midseason seed in recent years has been rarely above 20 per cent. and usually considerably less. In the case of the Dwalganup strain, how-

ever, figures as high as 79 per cent. have been secured with machine dressed seed and the averages for the 1935 and 1936 seasons were 36 per cent. and 18 per cent. respectively. In the northern States of America and also in Canada hardier strains exhibit a higher percentage of impermeable seeds than do the less hardy ones (3) thus giving a comparable result to that secured locally with subterranean clover.

Little experimental work has been done with "hard seeds" of subterranean clover and that which has been carried out was limited to the midseason strain. Harrison (5) describes an experiment in which seeds were planted on 29th May, 1929, and monthly germination counts made. During the first month 28.5 per cent. germinated, but no appreciable germination was then secured until February, 1930, when 27 per cent. germinated following a good rain. The balance of 71.5 per cent. after the initial germination, was considered to consist of "hard seeds." Comparative figures of 43 per cent. and 76 per cent. germination are also given for hand cleaned and machine threshed seed respectively, secured from the same sample of burr. Elliott (6) gives the average "hard seed" content of subterranean clover burr tested in Western Australia from 1923-26 as 71 per cent. and that of machine cleaned seed from 1923-29 as 30 per cent. He cites these figures as proving one of the advantages of sowing machine cleaned seed when compared with burr.

TABLE 1.—*"Hard Seed" Figures for 1935 Season.*

Producer.	District.	No. of Samples.	"Hard Seed" Content— Highest %	Lowest %	Average %
A.	Boyup Brook	82	79	8	41.7
B.	Boyup Brook	34	56	9	26.8
C.	Boyup Brook	8	42	3	21.1
D.	Muresk	9	40	19	26.9
	Total	133		Average ..	35.6

TABLE 2.—*"Hard Seed" Figures for 1936 Season.*

Producer.	District.	No. of Samples.	"Hard Seed" Content— Highest %	Lowest %	Average %
A.	Boyup Brook	32	40	2	20.0
B.	Boyup Brook	10	37	6	20.4
C.	Boyup Brook	15	13	1	6.4
E.	Boyup Brook	11	26	11	17.0
F.	Boyup Brook	2	36	26	31.0
G.	Narrogin	6	60	10	41.0
	Total	76		Average ..	18.2

After examining Tables 1 and 2 it is obvious that many lines of Dwalganup subterranean clover seed sold contain excessive quantities of "hard seeds" and the average of all tests conducted with 1935 season seed must be considered to be abnormally high.

At present Western Australia provides practically the entire seed supply of the Dwalganup strain, but must be prepared for strong competition on the Eastern States markets in the near future. Thus in order to definitely locate the cause and possibly suggest some means of overcoming this high figure, investigations were commenced in 1934 and continued during the past two years.

INVESTIGATIONS IN THIS STATE.

From time to time many suggestions have been advanced to explain the varying percentages of impermeable seeds in different lines of commercial Dwalganup subterranean clover and, with these in view, investigations have been carried out in an attempt to reach some conclusion. Consideration has been given to the following factors:—

Climatic conditions during the growing period.—Dry conditions, particularly at the time of seed setting, have been suspected of increasing the "hard seed" content of clovers, both in Australia and other countries and there is a certain amount of evidence in support of the contention. Stapledon (7), however, found that seed of white clover and red clover growing wild in England contained upwards of 82 per cent. and 87 per cent. of "hard seeds" respectively, thus indicating that a high "hard seed" content was not necessarily associated with a dry climate.

Locally the climate, apparently, is not directly linked with the *variation* in "hard seed" content of either commercial (machine cleaned) or hand cleaned Dwalganup subterranean clover seed. During 1936 samples of burr were taken from widely separated areas in the Boyup Brook district and from the Narrogin district. These were hand cleaned in order to reduce scarification to a minimum, but the "hard seed" content, which was high in every case, gave no indication of influence by different climatic conditions.

Paddocks less than one mile apart gave practically the maximum range of all the tests, viz., 55 per cent. and 78 per cent. "hard seeds," as 55 per cent. was the minimum and 86 per cent. the maximum of all tests conducted. The average figure for both the Boyup Brook and Narrogin districts was 75 per cent.

Although the high "hard seed" content experienced in all cases may be partly or entirely due to climatic factors, such as dry conditions at the time of seed setting, the comparatively slight variations in climate over the areas of production does not cause variation in this figure. There is every possibility, however, that the *degree* of "hard seededness" is directly affected and this aspect is being investigated. In the case of machine dressed seed no direct comparisons were possible owing to the different methods of machining affecting the germination.

Soil.—The production of Dwalganup subterranean clover seed is practically confined to light sandy soils which pass into laterite on some of the hillsides. The "hard seed" content of both hand-cleaned and machined seed did not show any obvious relationship with the differences in soil type.

The age of the pasture and time since previous gathering.—Producers frequently contend that seed gathered from old pastures, particularly those from which burr has not been collected for a number of years, contains a "hard seed" content higher than the average, even after machine dressing. There is some basis for this contention as an old pasture, theoretically, would contain a percentage of the "hard seed" content of a number of seasons. Each year the normal seeds would germinate immediately leaving an accumulation of "hard seeds" which would germinate at intervals for probably a considerable number of years afterwards. If burr was not gathered from an area for, say, ten years after sowing, it is reasonable to expect that there would be more "hard seed" present than if gathered three years after sowing.

In the following tables the two areas considered were very similar in soil type and the methods of gathering, hulling and grading were identical and performed by the same machines. As the harvesting and cleaning operations for both areas were completed in less than one month, time should not have proved an influencing factor.

TABLE 3.—*The Effect of Age of the Pasture, and time since previous gathering on "Hard Seeds."*

Area.	Sown.	First Gathered.	Samples.	Germination. Highest.	Germination. Lowest.	Germination. Average.	"Hard Seeds." Highest.	"Hard Seeds." Lowest.	"Hard Seeds." Average.
				%	%	%	%	%	%
A	1926	1936	4	82	74	78	26	17	22
B	1931	1936	7	89	79	86	20	11	14

Table 3 indicates that the age of the pasture linked with the time since the previous gathering, has an effect on the "hard seed" content of commercial seed, although not a major factor when the variation is compared with the range of 1 per cent.-60 per cent. "hard" seeds occurring in samples of the same harvest (1936).

Time of gathering.—Stapledon (5) states "it has been noted, moreover, that hardness appears to be at its maximum in the case of samples harvested late and when the seed has fully matured." In the case of Dwalganup subterranean clover the first harvesting is usually carried out early in January and by this time the plants are completely dead and hence no action of the plant itself can increase the maturity of the seeds. A wide range of figures lead to the conclusion that the time of gathering, *i.e.,* during the normal period January-March inclusive, does not affect the percentage "hard seed" content.

Machinery for hulling and grading.—Investigations have proved conclusively that the main cause of variation in the "hard seed" content is the type of machinery and the method employed during hulling and grading operations. Seed contained in the burr, as previously stated, has an average of approximately 75 per cent. "hard" seeds but during the machining process, culminating in the production of graded seed, scarification of the seed coat is, to a greater or lesser extent, carried out. This abrasive action, if sufficient to fracture or scratch the outer layer of the seed coat will make a normally "hard seed" immediately permeable to water.

TABLE 4.—*The Effect of Machine Cleaning on "Hard Seeds."*

Area.	Average of "Hard Seeds" Hand cleaned	Machine cleaned
	%	%
1	83	15
2	86	30
3	85	14
4	84	31 } *
		7 } *
5	75	56 } *
		12 } *
6	67	4
7	78	11
8	55	4
Average	75	18

*Seed hulled with two different machines—see Table 5.

Table 4 shows clearly the effect of machine cleaning on the "hard seed" content. Both whilst hand cleaning the burr and testing the resulting seed for germination care was taken to reduce abrasion of the seed coat to a minimum, thus providing a direct contrast with the machined seed.

The cleaning methods adopted for Dwalganup subterranean clover follow the same general principles, but differ in many details, and these details are the main causes of "hard seed" percentage variation. Seeds which remain enclosed within their white covering or pod are termed "coaty" seeds and the various treatments employed to brush off this coat have different scarifying effects according to the harshness of the treatment. Metal has greater abrasive powers than leather and fibre and different methods employ all three. Again the nature and setting of the metallic surface and the rate of motion can cause considerable variation in abrasive action.

The following table demonstrates very clearly different results secured with seed from the same paddock, but cleaned and graded with two different sets of machinery.

TABLE 5.—*Effect of Hulling Methods on "Hard Seeds."*

Area.	Machine.	"Hard Seed" Content. Highest.	Lowest.	Average.
		%	%	%
5.	1	60	51	56
	2	14	10	12
4.	3	36	26	31
	4	13	3	7

The only difference between machines 1 and 2 was the inclusion of an efficient "decoater" in the case of machine 2. Although 3 and 4 were different machines the essential alteration was the inclusion of a "decoater" along with machine 4.

Weather Conditions at Time of Threshing.—Both the rate and efficiency of threshing is reduced by a moist atmosphere. The machines cannot cope with nearly the amount of burr as under dry conditions, and with equal treatment the percentage of "coaty" seed is considerably greater.

TABLE 6.—*Comparative Germination of "Coaty" Seeds.*

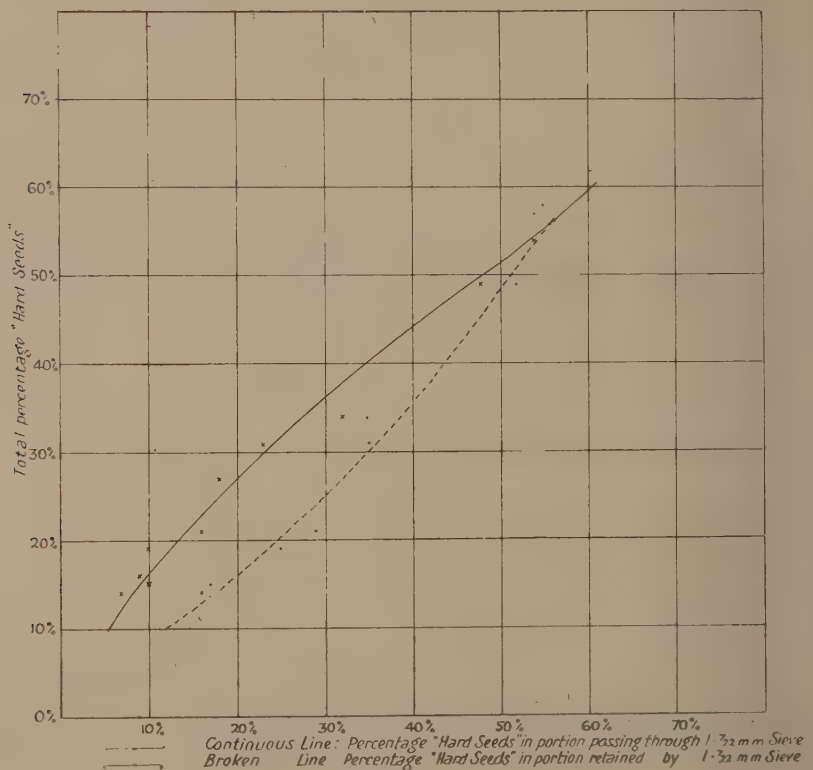
Sample.	Sample. Germination.	Sample. "Hard Seeds."	"Coaty" Seeds of Sample. Germination.	"Coaty" Seeds of Sample. "Hard Seeds."
	%	%	%	%
1	57	40	30	70
2	88	12	42	58
3	88	12	18	82
4	88	12	26	74
Average ..	80	19	29	71

As the figures from Table 6 show that "coaty" seeds contain a higher percentage of "hard seeds" than the corresponding samples from which they were taken, it follows that unless further machining is given to the seed under moist conditions the percentage of "hard seed" will increase. It is also interesting to note that the average "hard seed" content of "coaty" seeds is comparable with that of hand-cleaned seed, thus again confirming the scarifying action during the "decoating" process.

Size of Seed.—A sieve with slots of 1.7 x 22 mms was used to divide various samples of 100 seeds into two sections and the figures derived from germination tests with the sections are embodied in table 7 and graph 1.

TABLE 7.—*Effect of Size of Seed on "Hard Seed" Content.*

Sample.	Passed by 1.7 x 22 mms. Sieve.			Retained by 1.7 x 22 mms. Sieve.			"Hard Seeds" in Sample.
	No. of Seeds.	No. of "Hard Seeds."	"Hard Seeds." %	No. of Seeds.	No. of "Hard Seeds."	"Hard Seeds." %	%
1.	69	12	17	31	3	10	15
2.	73	12	16	27	2	7	14
3.	66	37	56	34	19	56	56
4.	63	22	35	37	12	32	34
5.	69	24	35	31	7	23	31
6.	65	13	20	35	3	9	16
7.	61	15	25	39	4	10	19
8.	20	11	55	80	47	59	58
9.	27	14	52	73	35	48	49
10.	44	24	55	56	30	54	54
11.	59	32	54	41	25	61	57
12.	42	12	29	58	9	16	21
13.	66	21	32	34	6	18	27



GRAPH I

The size of the seed is obviously associated with the total "hard seed" content, but the graphical representation of the relationship is not linear. With the total "hard seed" content approximately 30 per cent. or less the smaller-seeded section contained an appreciably larger percentage of "hard seeds" than the larger-seeded section. As the total "hard seed" content increased above 30 per cent., however,

this difference decreased until when approximately 55 per cent. was reached the two sections contained the same percentage of "hard seeds." Evidently with a high total "hard seed" content the *degree* of hard seededness is also high and makes purely latent any difference between seeds of different size in an average commercial line.

Storage.—As these investigations have been confined to the last two seasons little information regarding storage has been accumulated, but what is available suggests that the degree of hardness in Dwalganup subterranean clover seed is high.

Table 8.—*Variation in "Hard Seed" content during Storage.*

Sample.	Germination. %	"Hard Seeds." %	Date of test.	Germination. %	"Hard Seeds." %	Date of test.
1.	33	64	21/1/35	35	58	13/2/36
2.	44	54	8/2/35	51	45	13/2/36
3.	53	42	8/2/35	58	37	13/2/36
4.	41	57	8/2/35	49	48	13/2/36
5.	56	39	22/2/35	73	23	13/2/36
6.	61	35	1/3/35	54	44	13/2/36
7.	56	42	1/3/35	60	35	13/2/36
8.	62	31	11/3/35	67	28	13/2/36
9.	61	34	11/3/35	64	30	13/2/36
10.	61	36	13/6/35	60	34	13/2/36
11.	75	21	14/6/35	65	29	13/2/36
12.	65	31	15/6/35	65	30	13/2/36
Average ..	56	40		58	37	

The seed was contained in brown paper bags and stored in a cupboard at ordinary room temperatures. After a period of approximately one year, as shown in Table 8, the average "hard seed" content had decreased from 40 per cent. to 37 per cent. This represents a small decrease in comparison with the original large percentage and certainly indicates a high degree of "hard seededness" in Dwalganup subterranean clover produced under local conditions. It is intended to further test these samples at yearly intervals in order to ascertain any alteration in "hard seed" content under these storage conditions.

CONCLUSIONS.

In the main areas of production of Dwalganup subterranean clover seed in Western Australia the type of machine dressing, the size of seed, the weather conditions at the time of threshing and the age of the pasture, associated with the time since the last gathering, are factors influencing the "hard seed" content of commercial seed. By far the most important is the method of machining and this frequently eliminates any evidence of the other three factors. The "hard seed" content of seed in-the-burr is comparatively uniform and averaged 75 per cent. in 1936.

Many methods such as dry heat, hot water, and sulphuric acid may be used to reduce the number of "hard" seeds in legumes, but the most practical method in the case of Dwalganup subterranean clover is by scarification, *i.e.*, scratching the seed coat sufficiently to allow the intake of water. This is at present being done to a greater or lesser extent by producers and some of the so-called "decoaters" are very effective scarifiers. When these machines are efficient in this respect and can handle the seed rapidly, it is advisable, even in the absence of "coaty" seeds, to employ them in order to secure a good germination.

The large reduction in the average "hard seed" content from 36 per cent. in 1935 to 18 per cent. in 1936, was due to improved machinery and also the increased treatment required in some cases to produce seed in conformity with the purity requirements under the "Certification Scheme."

SUMMARY.

1. Literature is cited pertaining to the nature and variation of the "hard seed" content in legumes.

2. The significance of "hard" seeds is discussed.

3. The following factors with possiblities of influencing the "hard seed" content of commercial Dwalganup subterranean clover seed are considered:—

(a) Climatic conditions during the growing period;
(b) The age of the pasture and time since previous gathering;
(c) Time of gathering;
(d) Machinery for hulling and grading;
(e) Weather conditions at the time of threshing;
(f) Size of seed;
(g) Storage.

4. Under the conditions experienced in the present main centres of production (b), (d) (e), and (f) are factors influencing the "hard seed" content with (d) predominating and frequently eliminating the effect of the other factors.

5. The most practical method of reducing the "hard seed" content is by scarification at present most in evidence with machines of the so-called "decoater" type.

ACKNOWLEDGMENT.

The collecting of most of the samples used in this investigation was done by Inspectors of the Department of Agriculture connected with seed certification.

My thanks are due to these Inspectors and to the Chief Draftsman, Lands Department, Perth, who prepared the graph.

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THE DEVELOPMENT OF THE WESTERN AUSTRALIAN WHEAT BELT.

R. P. ROBERTS,
Agricultural Adviser.

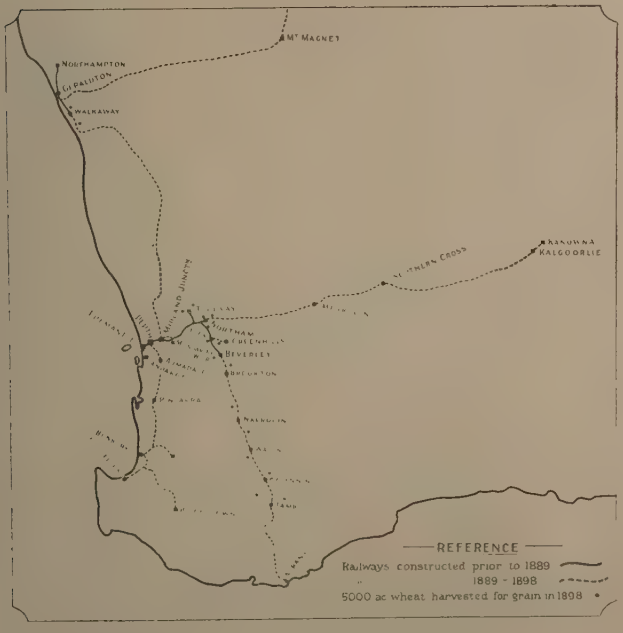
The following series of maps was prepared for Professor E. de C. Clarke to accompany his recent presidential address to the Royal Society of Western Australia on "Water Supply in the Kalgoorlie and Wheat Belt Natural Regions." It is felt that they are of sufficient general interest to warrant publication in this Journal.

Acknowledgments are made to the Government Statistician, the Government Railways and the Commonwealth Meteorologist, for supplying information, and to the Lands Department Officers who were responsible for the cartography.

The series is practically self-explanatory. The acreage planted with wheat for grain in each year under review is shown by a black dot for every 5,000 acres. Railways built in the preceding decade are shown by broken lines, while unbroken lines indicate earlier construction.

The year 1930 has been included in the series as that was the year of maximum wheat production in Western Australia.

NORTHAMPTON
GERALDTON
WALKAWAY
MIDLAND JUNCTION
TOODYAY
NORTHAM
YORK
BEVERLEY
FREMANTLE
PERTH
REFERENCE
Railways constructed to 1888
5000 ac wheat harvested for grain in 1888


MT MAGNET
NORTHAMPTON
GERALDTON
WALKAWAY
KANOWNA
KALGOORLIE
NORTHAM
BEVERLEY
REFERENCE
Railways constructed prior to 1889
1889 - 1898
5000 ac wheat harvested for grain in 1898

NORTHAMPTON
MT MAGNET
GERALDTON
WALKAWAY
LAVERTON
LEONORA
KANOWNA
KALGOORLIE
COOLGARDIE
SOUTHERN CROSS
DOWERIN
GOOMALLING
MERREDIN
WIDGEMOOLTHA
NORTHAM
TOODYAY
YORK
NEWCASTLE
QUAIRADING
PERTH
FREMANTLE
MIDDLE SWAN
GUILDFORD
BROOKTON
KALAMUNDA
ARMADALE
PINJARRA
NARROGIN
DUMBLEYUNG
WAGIN
BOYUP BROOK
KATANNING
KOJONUP
BRIDGETOWN
JARRAHWOOD
DENMARK
ALBANY
REFERENCE
Railways constructed prior to 1899
" " 1899 - 1908
5000 ac wheat harvested for grain in 1908

ANNA
NORTHAMPTON
YUNA
MT MAGNET
SANDSTONE
GERALDTON
MURCHISON
WALKAWAY
LAVERTON
LEONORA
KANOWNA
KALGOORLIE
COOLGARDIE
SOUTHERN CROSS
BINNU BIN
MERREDIN
BRUCE ROCK
QUAIRADING
NAREMBLEIN
WIDGEMOOLTHA
NORSEMAN
FREMANTLE
PERTH
GUILDFORD
KALAMUNDA
ARMADALE
BALLIDU
CRANBROOK
KOJONUP
LAKE BRACE
DUMBLEYUNG
NYABING
RAVENSTHORPE
HOPETOUN
KATANNING
JARRAHWOOD
NANNUP
BRIDGETOWN
DARDEE
ONGERUP
TAMBELLUP
DENMARK
ALBANY
REFERENCE
Railways constructed prior to 1909
" " 1909 - 1918
5000 ac wheat harvested for grain in 1918

AJANA
NORTHAMPTON
PORT GREGORY
HORROCKS
MULLEWA
WALKAWAY
MT MAGNET
SANDSTONE
LAVERTON
LEONORA
KANOWNA
KALGOORLIE
BULLFINCH
SOUTHERN CROSS
COOLGARDIE
MERREDIN
WIDGEMOOLTHA
NORSEMAN
NEWDEGATE
RAVENSTHORPE
HOPETOUN
ESPERANCE
BRIDGETOWN
DENMARK
ALBANY
REFERENCE
Railways constructed prior to 1919
" " 1919 - 1928
5000 ac wheat harvested for grain in 1928

AJANA
NORTHAMPTON
PORT GREGORY
MULLEWA
WALKAWAY
MT MAGNET
SANDSTONE
LAVERTON
LEONORA
KANOWNA
KALGOORLIE
BULLFINCH
SOUTHERN CROSS
COOLGARDIE
WIDGEMOOLTHA
NEWDEGATE
RAVENSTHORPE
HOPETOUN
BRIDGETOWN
DENMARK
ALBANY
REFERENCE
Railways constructed prior to 1929
" subsequent to "
5000 ac wheat harvested for grain in 1930
Growing period rainfall (May-October)

THE STICKFAST FLEA

Echidnophaga gallinacea (Westwood)

AND METHODS OF CONTROL.

By L. J. NEWMAN, F.R.E.S., Government Entomologist,
and
G. D. SHAW, Poultry Adviser.

Fleas in the adult stage may be said to be parasitic almost exclusively on warm-blooded animals. A great many birds and most mammals have been found to be infested by these blood-sucking parasites.

Fleas are true insects and belong to the order *Siphonaptera*. They are wingless, parasitic insects, possessing great powers of leaping. The food of the adults consists only of the blood of mammals or birds. Most people are familiar with these elusive little pests, knowing only too well their irritating bite and jumping powers.

In this State no flea has a more evil reputation than the Stickfast Flea. This pest was first described by the Entomologist (Westwood) from specimens of fleas received from Ceylon, where it occurred on poultry. It was first officially reported in this State in the year 1920. This flea is the most important of our livestock-infesting species. It is primarily a poultry pest, but is found infesting native birds and animals, horses, dogs, cats, rats, mice and rabbits. The adult fleas spend almost the whole of their existence attached to their hosts and do not roam over the body, as other species do.

In the case of poultry they are most commonly attached to the head, congregating in masses about the eyes, comb and wattles. When excessively abundant they may be found on the neck and various parts of the body. In the case of dogs, cats, rats, etc., they are found about the ears, nose, between the toes and any non-hairy parts of the body. Horses are chiefly infested about the fetlocks.

As regards poultry, with which this article deals, the injury is most marked in the case of young chickens. There have been numerous instances when they have actually died as the result of gross infestation. The older fowls are more resistant. The chief and important effect upon these is the great reduction in the number of eggs laid, and in the weight and size of the fowls and their greater susceptibility to disease.

Life History.—Like all fleas and many other insects there is a complete metamorphosis. This means that the Stickfast Flea passes through four distinct changes of form during its lifetime, namely, egg, larva or maggot, pupa and imago or adult hopper. Most people only recognise the one stage, the adult hopper. In a study of the life-cycle locally it was definitely proved that under favourable conditions these four stages, from egg to adult, occupy from four to five weeks.

The Egg.—This is a very tiny white to creamy-coloured, oval body, having a pearly lustre. Though it is small it can be seen by the naked eye. The egg is dropped to the ground by the female whilst it is feeding and attached to the host animal or bird. It hatches in from 4 to 6 days during the warm season of the year. During winter few eggs appear to be laid. Each female is capable of producing a great many eggs over an extended period.

The Larva or Maggot.—The tiny maggot which issues from the egg is a small worm-like creature, almost pure white and about 1/25th of an inch long. It is legless, eyeless, and has 13 body segments. The head is furnished with a blunt pair

of antennae or feelers and a mouth which has a comparatively strong pair of jaws. The maggot lives beneath the surface of the soil where it moves about freely in search of food. The food consists of partly digested blood of the host fowl or animals, which has been evacuated by the adult fleas and falls to the soil. The organic matter, vegetable or animal, such as is derived from the fowl droppings is also food

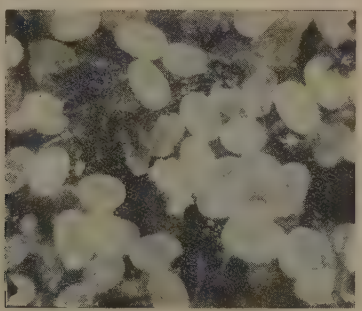


Figure 1.—Eggs of Stickfast Flea.
(Magnified 20 times.)

for the maggot. These materials, unless cleaned up regularly, find their way into cracks and crevices in the nesting boxes and are even mingled with the sand or soil about the roosting sheds, which all helps to provide breeding grounds and places for the flea. During the growing period of the maggot it passes through two moults. When full-grown the maggot measures about 1/8th of an inch in length.

Figure 2.—Larva or Maggot of Stickfast Flea.
(Highly magnified.)

The maggot period of life varies according to the available food supply, moisture, humidity and temperature. Moist summers are favourable, supplying enough dampness to the organic matter in the soil and dust in cracks to successfully mature the flea. Excessive moisture is unfavourable, and likewise excessive dryness and heat. When about to pupate the maggot works down deeper into the soil, some to a depth of 6 inches.

The Pupa.—After burying itself the maggot spins a small silken cocoon of more or less oval shape. This is white to brownish and often covered with particles of sand, dust or other organic matter. Within the cocoon the maggot moults its final skin and enters the pupal or resting stage. At first the pupa is very pale in colour, but gradually it darkens as the time for the issue of the adult approaches.

The pupation period may be lengthy or short, according to the time of year, averaging about 14 to 16 days in summer and hibernating during the winter months. At the end of the pupation period the adult flea splits the pupa case and emerges to carry on the reproduction of another generation.

The Imago or Adult.—The adult flea is dark brown to almost black and shiny and measures about 1 25th of an inch in length. It is much smaller than the common cat or dog flea. It is wingless but possesses well-developed legs which give it strong jumping powers. The mouth parts consist of a formidable arrangement of pointed and barbed organs. These specialised mouth parts enable the adult flea to pierce its host and at the same time to hold on, hence the common name of Stickfast. The Stickfast flea is difficult to remove from its host owing to the barbed

Figure 3.—Imago or Adult.
(Highly magnified.)

mouth parts. Usually when pulled out the proboscis has adhering to it a small piece of the bird or animal flesh. This indicates what a good hold this flea has. The female flea is larger than the male and is lighter in colour due to the abdomen becoming distended with eggs.

The habits of this flea are rather peculiar and differ from those of the ordinary fleas in that the former remains attached to its host, while other fleas only attach themselves during the actual period of sucking their host's blood. It appears that a meal of blood is necessary by the female before she can successfully produce fertile eggs.

The length of life of the adult depends upon the available food, which is blood, and climatic conditions. Moderately warm and moist weather is more favourable than cold weather. Hot dry weather soon proves fatal to the hoppers. Excess moisture in the soil, as has already been stated, is fatal to the maggots. Although the maggots are sensitive to adverse weather conditions, the eggs and pupae are able in a great measure to survive the winter. There are also a number of adult fleas which survive the winter on birds and animals, especially where they have the shelter of sheds, stables and fowlhouses. These carry-over stages are sufficient to start a fresh outbreak when the more favourable weather comes in. It is not likely that the Stickfast flea will ever be entirely eradicated. It may, however, be controlled to such an extent as to cease to be of any economic importance.

When first noticed in 1920, little was known generally of the control. This pest was very troublesome to the industry during 1923-1925.

Every design of drinking implement to oil automatically the heads of the birds was used. Houses and grounds were sprayed with every known means of destruction and patent solutions were sold by the hundreds of gallons until it was found that cement floors in houses eventually resisted the onslaughts of these little pests.

The life cycle above gives some idea of control methods. Laying its eggs at night time, the flea defeats its own reproduction if those eggs are laid from a fowl which is under control—one that is housed properly and forced to perch in that house. The eggs will then drop under the perches so that by cementing the floor of the house, the tiny maggot is prevented from boring into the soil.

When the egg hatches after having been deposited under the perch, the resultant maggot is either devoured by the fowls or its dies from want of nourishment. The adult flea, when it eventually reaches the age of death, is not then replaced by others.

Figure 4.—Note dark masses of Stickfast Flea on comb and wattles of fowl.

Cement flooring itself is not all that is required.

Any shady trees must have their bottom limbs so removed that the summer sun can penetrate all portions of the fowl yard at some time during the heat of the day.

One can with confidence suggest that the stickfast flea has been a blessing in disguise. The cementing of fowl house floors is the blessing conveyed to the industry by the invasion of stickfast fleas. The house is hygienic, easy to clean and to keep clean—quite a difference from the old earth or sand floors, which eventually became saturated with filth and disease.

When cementing the floor of a house, it is not necessary to make a concrete—any strong mixture of sand and cement is efficient.

In sandy districts one must always have a well tamped base, and nothing is easier than a mixture of sand and cement over which is floated a coating of a stronger mixture.

Divide the shed by placing boards in position to act as guides for the cement slab.

Using 3 x 2 timber on the flat, clean out all sand to the *bottom* of the board. Damp well and fill in with a mixture of 10 sand to 1 cement. Tamp firm and then scrape down to ½in. below the *top* of the board. Now make a mixture of 4 sand to 1 cement and place on top of the 10 to 1 mixture, tamp hard and scrape level with a striking board, using the edges of the 3 x 2 as a guide. Float over with a trowel and be careful to leave a ledge all round in order to confine the flea to the floor. The ledge need not be high. Care must be taken that the 10 to 1 mixture is not allowed to stand too long before the 4 to 1 is applied.

Should it be found impossible to place the 4 to 1 in position within six hours, it will be necessary to wet the 10 to 1, dust over some pure cement, and then apply the top layer.

When the top layer of 4 to 1 is trowelled down, cover with sand and keep wet for at least seven days.

When working on gravel or hard soil, 1in. thickness of 4 to 1 is applied direct to the gravel or hard soil base, tamped hard, floated and covered with sand as suggested above. Good clean sand must be used always, otherwise the cement will break up.

One must stress that the floor must be kept wet for at least seven days, for cement requires moisture in order for it to bind chemically.

When mixing the sand and cement, spread out the sand and cover with the quantity of cement desired. Shovel into a heap and mix either with rake or shovel until an even mixture is attained. Spread out and add water and mix thoroughly again. Ten kerosene tins of sand and 1 kerosene tin of cement under winter conditions need about 1 kerosene tin of water; other mixtures in proportion.

Tar or bitumen preparations are quite satisfactory and can be used. The main aim is to always have a floor which cannot be penetrated by the maggot. Cement, tar, wood and iron all can serve the same purpose.

Treatment of infested birds consists of the application of oil or grease to the parts affected.

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COMMON AILMENTS OF POULTRY—THEIR TREATMENT.

G. D. SHAW,
Poultry Adviser, Department of Agriculture.

Air Sac Swelling (Emphysema).

An abnormal condition showing air beneath the skin. This may be due to wounds, operations, or rupture of the organs containing air.

Treatment.—If the air swelling is caused by a wound or an operation the air sac may be punctured by slitting the skin, but should the trouble be due to a rupture there is no need to persevere with treatment, it is best to destroy the bird.

Paralysis.

This is a much-abused term, usually applied to any muscle weakness in legs, wings and neck.

Intense research has not as yet actually defined the trouble: numerous explanations have been given.

Sometimes it is said to be caused by worms, to coccidiosis, to lack of green feed, and to a virus that affects the nerves; all of which may cause a condition suggesting paralysis. As there is apparently no understanding as to the cause, treatment is difficult.

Lack of green feed can certainly cause a condition suggesting paralysis; tapeworm infection certainly causes a definite poisoning effect, which results in a condition similar to paralysis; but no diagnosis can be definite until examination of the carcase has taken place.

A fairly good gauge is to first check up on the green feed and then examine the droppings for tape-worm segments. Isolated cases of infection should be destroyed, but should the symptoms be prevalent in the flock it is suggested that, if the parent stock were of healthy strain, and a plentiful supply of green feed is available—the weakness stimulating paralysis is due to tape-worn infection.

Partial or complete loss of the use of the legs, wings or lack of strength in the neck to support the head, is a definite symptom of one of the above forms.

Paralysis in chicks is a condition where the chick cannot bear its own weight and is commonly called "leg-weakness."

Paralysis is always fatal, but if the cause of the weakness is lack of green feed or worm infestation the remedy is obvious.

Tuberculosis.

This is a serious disease and fowls which have it are a menace to the flock.

There are no marked symptoms. The fowls contracting this disease may not show any definite symptoms for a long period. In the meantime, before the trouble is suspected, others in the flock have been infected.

The most marked symptoms are loss of weight and extreme weakness. The infected birds have good appetites, but do not appear to keep body weight and this, together with ruffled plumage and pale eyes, head and comb, should lead one to suspect this disease. On post-mortem whitish-grey, hard, cheesy nodules of various sizes are found on liver, spleen and other portions of the internal organs.

The disease is transmitted in the droppings of the infected birds. These droppings foul food, water and the ground and other birds are thereby infected.

Treatment.—Owing to the seriousness of this disease it is advisable to clean up the whole flock by isolation of all possible contacts. No suspected infected bird should be allowed to remain on the property. Killing and burning is the best method of disposal. Direct sunlight will be the best means of cleaning an infected yard.

All sheds should be thoroughly cleaned and disinfected; yards ploughed up and covered with lime and not restocked for at least twelve months.

Pendulous Crop.

When the crop is baggy, large and hangs down, the trouble is called "pendulous crop." Generally noticed in aged hens it is caused through a breaking down of the muscles of the crop; it is unsightly, but may not inconvenience the bird.

Usually no treatment is called for, but for valuable birds one can operate and remove the disfigurement by proceeding as for a crop-bound bird.

Poisons.

Poultry may be killed through eating too much salt. As there are no symptoms and death follows too quickly, no treatment can be recommended.

Post-mortem examination in the case of birds dying from poison shows severe inflammation in either mouth, crop, or intestines.

Toe-picking.

This is a common vice in chicks which are not continuously occupied. As soon as one chick is attracted by something unusual about the foot of another chick it picks at it and blood follows. The remainder are soon attracted by the flow of blood and the vice is practised on others.

Toe-picking once started is hard to eliminate. It may cause severe mortality before it is checked. One can only endeavour by observation to find the ring-leaders and kill them off. The victims should be isolated and the injured toes dipped in Stockholm tar. The chicks must be kept occupied and made scratch in deep litter for their grain. The chick food should contain sufficient meatmeal and bonemeal and above all, plenty of space should be provided, as overcrowding is a general cause of toe picking. Ample space and work are the best preventives, but a sharp look-out should be maintained and the vice nipped in the bud at the first signs of the trouble.

Leukemia.—A disease due to an organism so small that it cannot be seen by a microscope and will pass through the finest filter.

Once established it is not easily eradicated. As it does not kill a large number of birds at one time, it is not easily suspected. The symptoms are such as not to attract the attention of the owner, and the birds usually are found dead for no apparent reason.

On post mortem the finding is usually a rupture of the liver with the abdomen filled with blood. There is a paleness of all tissue and in advanced cases the liver is white, porous and covered with nodules. The spleen is usually very enlarged and the heart covered with white lumps.

No effective means of control are known, and we are generally limited to the destruction of diseased birds. Cleanliness and sanitation are the only recommendations in order to keep the virus in check.

General.

From the utility farmer's point of view the recommendation should be the destruction of all sick birds. Such diseases as chicken-pox, catarrh, colds, etc., may easily be held in check, but with individual ailments a cure is not worth the time and money expended.

Individual cases of disease are only a source of danger, and the sooner they are separated from the flock the better.

Chicks and fowls that have had a severe check through illness are not worth feeding. The first loss is the lightest, for no amount of feed and attention will ever overcome the check.

Good breeding, feeding, continuous culling of weak, sickly birds, good housing, good clean yards and clean fresh water are best and the only means of prevention of disease. It should be the whole object of the farmer *to prevent* rather than to cure. New stock should never be introduced into the flock without a quarantine of at least four weeks. Should an owner have the misfortune to introduce disease into his flock, the best thing to do is to kill the birds and disinfect the infested premises. Finally, if the farmer cannot recognise the trouble, the diseased bird should not be buried, but forwarded immediately to the Department for examination.

Farmers should play safe always. No bird found dead should be buried without an examination or the certainty of the knowledge of cause of death. One must always be prepared for these troubles and a knowledge of the cause of death may be the means of providing against the infection of the living.

THE OFFICIAL AUSTRALIAN PURE BRED DAIRY CATTLE PRODUCTION RECORDING SCHEME.

1935-6.

G. K. BARON-HAY,
Superintendent of Dairying;

B. WILLIAMS,
Agricultural Adviser.

During the 1935-6 testing year ending 30th June, 367 cows completed their tests under the Official Herd Recording Scheme. It is gratifying to note the yearly increase in the number of pure-bred cows under test as it is realised that upon this comparatively small number of cows depends the supply of pure-bred sires ex tested dams for use in commercial herds of grade cows. The cows comprised 152 Jerseys, 68 Guernseys and 147 Australian Illawarra Shorthorns. The average production of all cows tested irrespective of age was 297.17 lb. butter-fat. The average butter-fat production for each class in each breed is shown in the following table:—

TABLE I.

Class.	A.I.S.		Guernsey.		Jersey.		All Breeds.	
	No. Cows.	Average Butter-fat.	No. Cows.	Average Butter-fat.	No. Cows.	Average Butter-fat.	No. Cows.	Average Butter-fat.
Mature	42	323·72	22	382·12	39	340·55	103	342·58
Senior Four-year-old ...	11	361·24	7	273·28	13	346·24	31	335·12
Junior Four-year-old ...	9	325·51	3	345·81	14	314·39	26	321·79
Senior Three-year-old ...	13	305·59	6	283·78	15	319·53	34	307·88
Junior Three-year-old ...	19	301·93	8	330·32	17	281·88	44	299·35
Senior Two-year-old ...	9	263·76	5	275·86	16	249·50	30	258·17
Junior Two-year-old ...	44	235·40	17	242·90	38	240·75	99	238·74

The trophy for the Champion Herd Sire was won this year by Triumph of Pine Creek (2515), an Australian Illawarra Shorthorn bull, owned by the Wooroloo Sanatorium Farm. Thirteen daughters of this sire passed their respective standards with an average production of 8,544 lb. milk and 383.51 lb. butter-fat. Two of these daughters were mature cows, five were senior four-year-olds, two senior three-year-olds and four junior two-year-olds.

TABLE II.

THE OFFICIAL AUSTRALIAN PURE BRED DAIRY CATTLE PRODUCTION RECORDING SCHEME.

Cows which Completed Test from 1st July, 1935, to 30th June, 1936.

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb.	%	lb.		
COWS OVER 5 YEARS OLD (MATURE)—STANDARD 350 LB. BUTTER-FAT.											
Yallah Farm Maggie II. ...	A.I.S. ...	1272	30-8-28	15-9-35	273	26	16,398	3·93	644·38	W. G. Burges ...	Fussy's Fave of Parkview (2149)
Tabbagong Dove 4th	do. ...	14725	30-9-26	18-7-35	273	16·5	15,050	3·92	589·99	W. G. Burges ...	Mayflower Repeater of Hillview (905)
Banyule Silvermine 55	Jersey ...	25473	2-8-28	18-6-35	273	25·5	11,147	5·38	573·27	Sabina Vale Stud Farm	Air Lord of Banyule (3337)
Wooroloo Rose II.	A.I.S. ...	2523	27-4-29	1-9-35	273	22	11,796	4·74	558·46	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Grass Vale Lily's Pride ...	Jersey ...	28228	10-2-29	17-2-35	273	29	8,967	5·82	521·53	C. J. Cunningham ...	Starbright Sweet Duke of Glen Iris (3710)
Kurrawong Kitty 8th	A.I.S. ...	16030	6-8-26	24-10-35	273	16	10,683	4·75	508·12	W. G. Burges ...	Premier of Kurrawong (1212)
Koojan Bonnie Jean	Guernsey...	1612	28-3-26	12-2-35	273	24	8,772	5·76	505·20	A. W. Padbury ...	Robin of Nundorah (417)
Nancy 9th of Raleigh	A.I.S. ...	17519	30-4-27	20-11-34	273	29	9,460	5·29	500·02	D. Bevan & Sons ...	Union Jack of Raleigh (2375)
Karridale Queen	Guernsey...	2754	27-11-28	6-3-35	273	30	9,095	5·33	484·85	P. G. Hampshire & Son	Minnamurra Oliver Twist (528)
Minnamurra Sun Lady ...	do. ...	2811	25-2-30	13-4-35	273	20·5	7,921	6·03	477·47	Muresk Agricultural College	Minnamurra Justice
New Park Sally 9th	A.I.S. ...	1873	30-4-29	23-4-35	273	22	13,116	3·55	463·34	W. G. Burges ...	Ruler of Greyleigh (1855)
Grass Vale Daisy II.	Jersey ...	23654	28-8-26	12-4-35	273	22	8,061	5·76	460·77	L. C. Field	Carnations Masterpiece of Garden Hill (2065)
Brookfield's Lady Lillian ...	Guernsey...	2720	28-11-29	27-7-35	273	25	9,525	4·80	456·42	P. G. Hampshire & Son	Koojan Lord Barclay (1031)
Granglea Pretty Primrose ...	Jersey ...	33038	31-10-29	19-6-35	273	23	7,861	5·84	454·38	Sabina Vale Stud Farm	Banyule Airo (5751)
Minnathorpe Treasure 5th ..	A.I.S. ...	2477	20-10-29	15-8-35	273	27	9,771	4·62	450·96	R. Bee & Sons ...	Collier of Darbalara (1997)
Claremont Mavis II.	do. ...	2411	3-3-28	16-4-35	273	34·5	11,998	3·74	448·90	Claremont Hospital for Insane	Telyarup Prince of Claremont (2352)
Jess of Grass Vale	Jersey ...	20872	5-8-25	28-4-35	273	16	8,733	5·32	433·35	C. H. Ironmonger ...	Starbright Sweet Duke of Glen Iris (3710)
Minnamurra Palm Olive ...	Guernsey ..	2616	30-8-29	17-4-35	273	25·5	8,041	5·38	432·85	Muresk Agricultural College	Caramana Favour
The Wold Daisy Northwood ...	Jersey ...	25064	11-7-28	25-4-35	273	19	6,927	6·25	431·75	L. C. Field	Grass Vale Northwood King (5620)
Clarendon Eyre Betty	do. ...	39244	28-4-28	20-5-35	273	19·5	10,341	4·20	426·45	Sabina Vale Stud Farm	Clarendon Eyre Emminant's Achievement (4154)
Banyule Silvermine 66th ...	do. ...	28847	10-9-29	14-7-35	273	20	7,995	5·30	422·47	Sabina Vale Stud Farm	Milkmaid's Chief of Banyule (1412)
Bellefaire's Spotted Socks ...	do. ...	26745	19-2-27	9-4-35	273	24	7,572	5·63	421·80	Mrs. G. H. Burnside	Werribee Prince Twylish
Cookalabai Jewel	Guernsey...	3771	18-9-29	27-2-35	273	27	8,721	4·72	411·42	A. W. Padbury ...	Cookalabai Pride II.
Minnamurra Prairie Belle ...	do. ...	2619	2-11-29	28-3-35	273	24	8,217	4·93	405·81	Muresk Agricultural College	Minnamurra Rex (1322)
Karridale Pride	do. ...	1981	16-10-27	24-2-35	273	28·5	8,111	4·99	405·14	P. G. Hampshire & Son	Minnamurra Oliver Twist
Koojan Wavelet	do. ...	1619	7-8-26	10-10-34	273	22	7,956	5·08	404·46	A. W. Padbury ...	Robin of Nundarah (417)
Berrington Soprano II. ...	Jersey ...	28851	5-10-29	21-7-35	273	16	7,998	5·04	403·00	Sabina Vale Stud Farm	Banyule Superstrain (4529)
Summerlea Red Rose	A.I.S. ...	Vol. VIII	1-8-26	23-4-35	273	24·5	10,919	3·75	402·00	Dunkley Bros. ...	Musket of Claremont
New Park Amy 7th	do. ...	1865	14-6-29	10-3-35	273	19	10,767	3·68	396·41	W. G. Burges ...	Ruler of Greyliegh (1855)
Minnathorpe Carnation 4th ...	do. ...	2475	2-8-28	20-8-35	273	27	9,681	4·08	394·16	R. Bee & Sons ...	Collier of Darbalara (1997)
Grantham Starbright Queen ...	Jersey ...	28232	8-8-29	9-8-35	273	17	8,091	4·86	393·44	J. A. Sears	Grantham Starbright King (5796)

Wingeewah Silver III.	A.I.S. ...	1547	4–10–28	5 5–05	273	13	9,211	4·12	391·06	A. Della	Karawarra Werri (2759)
Koojan Dorothy	Guernsey	1613	27–6 26	12–7–35	273	16	7,923	4·97	390·08	J. R. Giles	Koojan Golden Governor (595)
Minnamurra Eleanor	do. ..	2607	13 8 29	11 8 35	273	18	8,289	4·70	388·34	Muresk Agricultural College	Caramana Favour (652)
Tipperary Melba III.	A.I.S. ..	2358	11–10 29	17 6 35	273	33	9,579	4·06	386·36	R. Bee & Sons ...	Melba's Re-Echo of Tipperary
Muresk Carnation	Guernsey	1800	30–5 27	20–0–35	273	22	7,446	4·07	383·40	Muresk Agricultural College	Triumph of Wollongbar (513)
Banyule Silvermine 59th ...	Jersey ...	29033	10–2–29	23–8–35	273	17	7,536	5·07	382·37	Sabina Vale Stud Farm	Banyule Superstrain (4529)
Wooroloo Red Rose	A.I.S. ...	2521	17–2 28	22–4 35	273	5·5	8,252	4·80	379·28	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Gold 11th of Rayliegh	do. ...	17507	16–10–27	10 9–35	210	31	10,080	3·73	376·35	D. Bevan & Sons ...	Royal Standard of Darbalara (2908)
Wyuna Jean	Guernsey...	2471	8–9–29	2–8–35	273	12	7,776	4·81	374·49	Muresk Agricultural College	Nundarah Buccaneer
Muresk Rose	do. ...	2156	9–5–28	20–8 35	273	9	7,777	4·81	374·27	Muresk Agricultural College	Triumph of Wollongbar (513)
Claremont Pansy III.	A.I.S. ...	2413	18 9 28	18–12 34	273	19	10,917	3·43	374·02	Claremont Hospital for Insane	Clinker of Claremont (2486)
Moorlands Bridget	Jersey ...	24920	1 6 27	5–5 35	273	9	7,662	5·20	371·66	Estate late P. Rose ...	Colonel of Melrose (4015)
Stonehill Golden Belle	do. ...	28195	25–7–27	6 11–34	273	12	7.101	5·22	370·79	C. Kreins	Lassie's Chief of Rocklands (3985)
Woodendale Shirlie	do. ...	28175	8 7–28	27–5 35	273	17·5	7,178	5·13	367·94	F. P. Atwell	Mokine Lady's Chief
Muresk Primrose	Guernsey...	2527	3 3–29	6 8 35	273	19·5	6,644	5·50	365·54	Muresk Agricultural College	Triumph of Wollongbar (513)
Wollongbar Golden Pearl V. ...	do. ...	1128	8–9–24	5–4–35	273	21·5	6,739	5·41	363·89	Muresk Agricultural College	Judge of Wollongbar (184)
Glanavon Verna	A.I.S. ..	2369	6 4 29	24–11 34	273	20	8,638	4·21	363·39	E. T. Thatcher ...	Pine Creek Dunbar (439)
Grantham Lady Fowler III. ...	Jersey ..	24933	7 7–28	2–8–35	273	14	6,572	4·00	362·80	J. A. Sears	Merry King of Greenmount (4306)
Newstead Daisy 12th	do. ...	12955	28 5–30	21–8–35	273	13	8,559	4·24	362·79	W. G. Burges ...	Superb of Newstead (2911)
Vision of Blacklands	do. ...	12082	2 5 26	23–4–35	273	13	8,574	4·30	362·53	W. G. Burges ...	Fussy's Monarch of Hillview
Springmead Fern	Jersey ...	27213	5 3–28	24 7–35	273	19	6,972	5·10	359·27	Sabina Vale Stud Farm	Springmead Islander (4359)
Crantocks Cream Star	do. ...	34723	14 8 28	20–5–35	273	9	5,502	6·65	358·86	Mrs. G. H. Burnside	Crantock Starbright's Chief (5790)
Tipperary Priscilla	A.I.S. ...	2359	9 9–29	16–3 35	273	31	8,163	4·31	351·94	R. Bee & Sons ...	Villiers of Darbalara (2386)
Willow Glen Ruby 6th ...	do. ...	...	18–8 25	1 2 35	273	34	10,092	3·48	351·94	A. Della	Lord Denmore of Willow Glen (1111)
Flash of East View	do. ...	18031	4 10–28	1–9–35	240	8	8,685	4·04	350·04	A. E. Grant	Mariner of Greyliegh (587)
Wollongbar Betty 2nd	Guernsey...	1571	4–7–26	26 8 35	273	16	6,783	5·10	346·78	Muresk Agricultural College	Bounty of Wollongbar (336)
Granglea Buttercup	Jersey ...	26388	21–3 27	18–5 35	273	14·5	7,012	5·57	345·56	Sabina Vale Stud Farm	Granglea's Dairy's V.C. (5079)
Woodendale Hope	do. ...	34335	2 5 29	28–5–35	273	22	7,011	5·00	345·23	F. P. Atwell	Mokine Lady's Chief (4911)
Wooroloo Alice II.	A.I.S. ...	2517	19 4 28	4–8 35	273	15·5	6,937	4·90	342·88	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Valerie of Aorangi	do. ...	17086	4–7–27	20–11 34	273	12·5	7,697	4·43	340·52	E. C. Melville ...	General Maud of Aorangi (1014)
Nooka Wild Rose	Jersey ...	28191	31 12–28	16–2–35	273	20·5	6,910	4·90	338·43	S. P. Herbert ...	Montrose East of Glen Iris (4140)
Summerlea Tulip III.	A.I.S. ...	5139	5 9 28	25 3–35	273	21	7,870	4·11	323·57	Dunkley Bros. ...	Victor of Telyarup (2498)
Denmark Rose Dame	Guernsey ..	1794	19 8–27	13–3–35	273	24	7,092	4·65	330·36	Denmark Research Station	Rose Chief of Wollongbar (130)
Grass Vale Cream Goods ...	Jersey ...	34814	28–8 29	9 10 35	273	19·5	7,304	4·48	327·39	R. H. Rose	Choice Goods of Garden Hill (4580)
Stonehill Mary II.	do. ...	31197	4–10 29	5 11 34	273	15	6,195	5·25	325·64	C. Kreins	Grass Vale Carnation's Best (7290)
Moorlands Clara	do. ...	28215	18–8–28	5–5–35	273	7	6,861	4·94	324·99	Estate late P. Rose ...	Grafter of Melrose
Star Ferns Princess of Glen Iris	do. ...	14175	18 8 23	11 4–35	273	14·5	5,556	5·85	324·58	L. Temple	Starbright Prince of Glen Iris (3345)
Summerlea Tulip II.	A.I.S. ...	5139	5 9–28	25 3–35	273	21	7,870	4·11	323·57	Dunkley Bros. ...	Victor of Telyarup
Mondah Princess III.	do. ...	.	7–4–30	16–6–35	273	13·5	7,961	4·05	322·50	A. Della	Pine Creek Banker
Moorlands Doris	Jersey ...	31235	14–5–29	29–5–35	240	14	6,435	4·94	317·66	Estate late P. Rose...	Moorlands Romeo
Colmyn Nellie Rye	do. ...	34754	8 7–30	1 9–35	273	14	7,167	4·38	313·88	C. H. Ironmonger ...	Colmyn Captain Mac (5833)
Grantham Lady Fowler 5 ...	do. ...	28231	17–5–29	30–10–34	273	12	5,466	5·63	308·01	L. Temple	Grantham Starbright King
Wyuna Lady Dawn	Guernsey...	2472	12–11 29	21–3–35	273	22	6,156	4·97	306·44	Denmark Research Station	Nundorah Prosper (664)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb.	%	lb.		
COWS OVER 5 YEARS OLD (MATURE)—STANDARD 350 LB. BUTTER-FAT.											
Tipperary Royal Lady	A.I.S.	2377	13-11-28	12-10-34	273	19	6,942	4·39	304·54	W. G. Burges ...	Tipperary Melba's Re-Echo (2452)
Denmark Rosa III.	Guernsey...	2523	5-4-29	11-7-35	273	13	5,979	5·09	304·37	Denmark Research Station	Wollongbar Reformer (538)
Wollongbar Rosebud II. ...	do. ...	2789	10 1 30	4-6-35	273	11	5,823	5·23	301·58	Denmark Research Station	Wollongbar Satisfaction (960)
Claremont Polly II.	A.I.S. ...	2419	19 1-29	30-9-35	240	27	8,520	3·50	298·53	Bayley Bros. ...	Clinker of Claremont (2456)
Mereworth Queen	Jersey ...	28198	6 6-29	8 8-35	210	14	5,115	5·53	283·03	B. Langridge ...	Melrose Romeo (5861)
Moorlands Ethel	do. ...	34808	2 4-30	31-5 35	210	7	4,710	6·26	282·27	Mrs. G. H. Burnside ...	Melrose Raleigh (5860)
Crantock Lady Bluebell ...	do. ...	34724	26-5 29	16-11-34	273	7	4,812	5·09	281·90	S. P. Herbert ...	Crantock Starbright's Chief (5790)
Nooka Lass	do. ...	28187	14-1-29	17-3-35	273	21	6,670	4·17	278·02	Wooroloo Sanatorium Farm	Jessie's King of Sarnia (4578)
Wooroloo Gem III.	A.I.S. ...	2519	25-12-28	22-10 34	273	12·5	7,772	3·56	277·02	P. G. Hampshire & Son	Triumph of Pine Creek (2515)
Cookalabai Pearl	Guernsey...	3772	29-10-29	22 1-35	210	20·5	6,105	4·49	274·14	Estate late P. Rose ...	Cookalabai Pride II. (2456)
Moorlands Aline	Jersey ...	23683	16-7-26	9-3-35	273	17	6,726	4·01	269·79	Bayley Bros. ...	Colonel of Melrose (4015)
Claremont Lupin II.	A.I.S. ...	17918	28-7 26	13-6-35	273	10	8,175	3·10	263·37	J. R. Giles	Telyarup Prince of Claremont
Koojan Golden Hope	Guernsey...	2663	31-8-28	4 10 35	240	14	4,545	5·43	246·78	A. E. Grant	Koojon Golden Governor (595)
Telyarup Della II	A.I.S. ...	2503	11-11-28	28-4-35	180	22	5,970	4·00	246·72	F. P. Atwell	Baron of Darbalara (2824)
Greenmount Bo-Peep's Fancy ...	Jersey ...	...	21-6-30	11 7 35	210	16	4,320	5·75	244·65	Estate late P. Rose ...	Werribee Starbright King (2602)
Moorland's Cuptal	Jersey ...	28225	31-7-28	9-6-35	240	5·5	5,295	4·61	242·85	Dunkley Bros. ...	Grafter of Melrose (3560)
Summerlea Dairymaid II. ...	A.I.S. ...	15099	3-3-26	1-8 35	210	19	6,840	3·34	228·78	R. Bee & Sons ...	
Tipperary Melba	do. ...	17902	26-9-27	6-11-34	273	19	4,812	4·70	219·00	A. J. B. Strempel ...	
Greenmount Charming Lass ...	Jersey ...	20903	3-6 25	2-9-35	120	28	3,975	5·51	218·94	L. Temple	Werribee Starbright's King (2602)
Moorlands Dot	do. ...	31236	16-5 29	8-8-35	240	4	4,815	5·14	215·16	Estate late P. Rose ...	Melrose Romeo (5861)
Moorlands Bebe	do. ...	24912	21 4-27	20 4-35	210	18·5	4,875	4·07	199·11	Bayley Bros. ...	Grafter of Melrose (3560)
Claremont Ulery	A.I.S. ...	2424	19-6 29	30-5-35	210	10	5,430	3·53	191·73	Claremont Hospital for Insane	Claremont Evan (447)
Claremont Flynn 10th	do. ...	2403	30 6-29	28 8-35	150	24	4,980	3·80	181·62	Claremont Hospital for Insane	Claremont Evan (447)
Denmark Irish Rose	Guernsey...	2154	11 10-28	11-11 35	210	7	3,480	5·02	174·65	J. R. Giles	Rose Chief of Wollongbar (130)
Denmark Red Rose V. ...	do. ...	2793	17 11 29	13-11 35	210	9	3,435	5·00	171·82	J. R. Giles	Reformer of Wollongbar (538)
Victress of Toora	A.I.S. ...	17887	7 3-28	29-7-35	60	62	3,150	4·63	145·77	A. E. Grant	Victor of Darbalara (2384)
Moorlands Duetto	Jersey ...	31240	22 5-29	8-1 35	150	12	2,505	5·42	135·96	L. Temple	Melrose Raleigh (5860)
Claremont Lily 4th	A.I.S. ...	5120	1-3-30	23 8-35	90	24·5	3,105	3·51	109·11	Claremont Hospital for Insane	Searchlight of Sunnyvale (2302)
Willow Glen Beauty 11th ...	do. ...	15511	27-9-25	24-5-35	90	30	2,880	3·63	104·62	A. Della	Lord Denmore of Willow Glen (1111)
Claremont Maggie Morrison 6th	do. ...	...	22-11-27	2 9-35	60	32	2,400	3·79	90·84	Claremont Hospital for Insane	Searchlight of Sunnyvale (2302)
Karridale Queen	Guernsey...	2754	27-11-28	16-2-36	30	27	1,950	4·60	90·75	P. G. Hampshire & Son	Minnamurra Oliver Twist (528)
Moorlands Etna	Jersey ...	34804	20 4-30	30-11-35	90	18·5	1,860	4·30	78·42	Estate late P. Rose ...	Melrose Raliegh (5860)
Plum III. of Karrawarra ...	A.I.S. ...	1261	27-4-28	9-11-35	30	55	1,650	3·70	60·96	W. G. Burges ...	Sailor of Karrawarra (Fdn.)
Willow Glen Beauty 11th ...	do. ...	15511	27 9 25	14-3 36	30	29·5	885	3·80	33·36	A. Della	Lord Denmore of Willow Glen (1111)

COWS OVER 4½ YEARS AND UNDER 5 YEARS OLD—STANDARD 330 LB. BUTTER-FAT.

The Wold Starbright Daisy ...	Jersey ...	31179	8 7 30	23-5-35	273	22	8,346	5·92	505·74	L. C. Field	Grantham Starbright's King (5796)
Wooroloo Bloomer	A.I.S. ...	5248	5-10-30	4 5-35	273	19·5	110,39	4·53	498·32	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Blacklands Jeanette 7th ...	do. ...	9324	1-1-31	29-7-35	240	28	11,955	3·70	446·06	W. G. Burges ...	Fussy's Monarch of Hillview (493)
Walgett Fortune	Jersey ...	42401	10-11-30	2-6-35	273	16·5	8,532	5·19	443·07	C. J. Cunningham ...	The Valley Twylish Fox (5023)
Greenmount Starbright's Marinora	do. ...	34841	31-5-30	28-3-35	273	21·5	7,729	5·72	442·28	A. J. B. Strempel ...	Werribee Starbright's Butter King
Springmead Lady Rose ...	do. ...	...	26-7-30	28-6-35	273	23	9,549	4·57	432·55	Sabina Vale Stud Farm	Springmead Beaucaire (6315)
Wooroloo Betty 2nd	A.I.S. ...	7734	10-11-30	8-9-35	273	12	9,276	4·19	388·60	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Wooroloo Red Rose 3rd ...	do. ...	5226	27-9-30	9-6-35	273	14	8,217	4·84	387·45	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Blacklands Miss Jean 6th ...	do. ...	9356	21-8-30	10-3-35	273	23	8,950	4·22	377·90	W. G. Burges ...	Red Prince of Blacklands (1064)
Blacklands Lady Fanny 2 ...	do. ...	9330	25-8-30	13-4-35	273	24	9,696	3·95	375·48	W. G. Burges ...	Red Prince of Blacklands (1064)
The Pines Bell	do. ...	4079	6-9 30	16-7-35	273	20	9,480	3·80	368·72	E. T. Thatcher ...	Democrat of Alne Bank (1625)
Wooroloo Margaret	do. ...	5223	7-10-30	3-8-35	273	12	8,091	4·37	353·28	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Karridale Girlie	Guernsey...	3820	24-9-30	25-7-35	273	18	6,654	5·30	350·59	P. G. Hampshire & Son	Minnamurra Rose Chief (1016)
Glanavon Edna	A.I.S. ...	2361	10-7-30	28-1-35	273	23	8,079	4·20	346·52	D. Bevan & Sons ...	Raleigh Regent (463)
Muresk Poppy	Guernsey...	3293	8-8-30	26-6-35	273	15·5	5,792	6·05	345·74	Muresk Agricultural College	Triumph of Wollongbar (513)
Moorlands Evelyn	Jersey ...	34811	28 8-30	23-4-35	240	11·5	6,705	5·80	340·86	Estate late P. Rose ...	Melrose Romeo (5861)
Wooroloo Lass	A.I.S. ...	7740	30 12 29	31-10-34	273	20	8,580	3·96	340·06	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2512)
Burnside Cream Lass	Guernsey...	3319	17-9-30	1 6-35	240	13	6,360	4·76	339·55	J. R. Giles	Grantham Starbright's King
Greenmount Beauty	Jersey ...	44197	10-10-30	23-6-35	273	11·5	6,575	5·13	339·35	F. P. Atwell	Grantham Starbright's King (5796)
Nooka Ragtime Rose	do. ...	34743	7-4 30	16-1-35	273	14	5,007	6·45	322·87	S. P. Herbert ...	Springpark Prince Ragtime (5942)
Woodendale Buttercup ...	do. ...	34715	24-9-30	25-5-35	273	15·5	6,497	4·87	312·15	F. P. Atwell	Mokine Lady's Chief
Moorlands Elaine	do. ...	34800	13-5-30	13-3-35	273	15·5	5,121	5·95	304·90	Estate late P. Rose ...	Melrose Romeo (5861)
Nooka Twylish Madiera ...	do. ...	34744	16-7-30	13-3-35	273	17	6,456	4·61	297·63	S. P. Herbert ...	Springpark Prince Ragtime (5942)
Denmark Rose Pearl V. ...	Guernsey...	2381	20-8-30	18-8-35	273	7	5,001	5·68	283·94	Denmark Research Station	Reformer of Wollongbar (538)
Mereworth Starbright's Belvedere	Jersey ...	34763	2-10-30	6-9-35	273	9·5	5,879	4·70	275·90	B. Langridge ...	Grantham Starbright's Northwood (5941)
Moorlands Elsie	do. ...	34803	12-6-30	10-4-35	240	11	5,062	5·24	265·35	Estate late P. Rose ...	Melrose Romeo (5861)
Kudardup Pansy	Guernsey...	2927	16 1 31	24-11-35	210	12	4,320	5·82	251·55	J. R. Giles	Newry Golden Prince (977)
Koojan Dairymaid	do. ...	3543	13-2-31	17-8-35	120	29·5	4,305	5·43	233·97	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Crantock Starbright's Duchess ...	Jersey ...	39440	15-10-30	4-8-35	240	8	3,825	5·79	223·60	Mrs. G. H. Burnside ...	Crantock Starbright's Chief (5790)
Wooroloo Jean	A.I.S. ...	5221	15 7-30	31-1-35	90	27·5	3,195	4·01	128·01	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Muresk Bluebell	Guernsey...	3284	17-8-30	16-4-35	90	21·5	2,445	4·40	107·61	Muresk Agricultural College	Muresk Mineliaus

COWS OVER 4 YEARS AND UNDER 4½ YEARS OLD—STANDARD 310 LBS. BUTTER-FAT.

Springmead Josephine	Jersey ...	42003	10-6-31	7-8-35	273	13·5	7,346	6·44	473·30	Robinson Bros. ...	Bellefaire Blonde's Corsican (7040)
Wigdee Waa Rosy V.	A.I.S. ...	5117	20-4-30	17-10-34	273	32·5	11,392	4·04	461·53	W. G. Burges ...	Parkview Mayflower's Monarch (2049)
Grass Vale Buttercup	Jersey ...	40072	28-6-31	4-9-35	273	16	7,428	5·94	442·74	R. H. Rose ...	Campanile's Duke of Burekup (7287)
Tabbagong Fairy 8th ...	A.I.S. ...	7514	14-7-31	9-9-35	273	12·5	10,358	4·24	439·19	W. G. Burges ...	Parkview Renard II. (260)
Colmyn Buttercup ...	Jersey ...	39319	10-10-31	13-10-35	273	21·5	8,540	5·11	436·32	C. H. Ironmonger ...	Rye Duke of Glen Iris (1994)
Milbank Joan 4th ...	A.I.S. ...	4976	7-5-31	23-6-35	273	13	10,479	4·09	428·30	Dunkley Bros. ...	Parkview Ruler (309)
Koogan Ace's Marigold ...	Guernsey...	3541	22-1-31	25-6-35	273	22	7,181	5·00	397·66	P. G. Hampshire & Son	Homestead Ace (imp. U.S.A.) (1631)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb.	%	lb.		
COWS OVER 4 YEARS AND UNDER 4½ YEARS OLD—STANDARD 310 LBS. BUTTER-FAT—*continued.*											
Grantham Air Lady	Jersey	34824	18 7 30	5 3 35	273	22	7,251	5·18	375·50	J. A. Sears	Banyule Altitude (5793)
Grantham Starbright Carnation	do.	34825	24-3-31	1 9-35	273	15	6,795	5·07	344·65	J. A. Sears	Werribee Starbright King (2602)
Koojan Twiddlewinks	Guernsey	3546	24-9-30	16-11-34	273	18	6,759	4·98	336·76	A. W. Padbury	Homestead Ace (imp. U.S.A. (1631)
Tirano Princess	A.I.S.	7677	22-12 30	1 3-35	273	26	7,510	4·40	330·45	A. Della	Pine Creek Banker (450)
Crantock Cream Lass	Jersey	43542	7-6-31	2-8-35	273	8	4,584	7·10	327·73	Mrs. G. H. Burnside	Crantock's Starbright Montrose (5945)
Swanlea Lovely 7th	A.I.S.	4284	12-2 31	29-5-35	273	19·5	8,609	3·77	323·22	A. E. Grant	Headlight of Parkview (1406)
Summerlea Tulip 4th	do.	14256	21-5-31	30-6-35	273	17	7,821	4·13	322·96	Dunkley Bros.	Summerlea Searchlight (972)
Mereworth Bankers Fondant 2nd	Jersey	40996	30-3-31	1-7 35	273	10	5,355	5·71	305·22	B. Langridge	Grantham Easter King (6510)
Denmark Rose Dame II.	Guernsey	3280	18 8-31	22-8-35	273	7	5,901	5·11	301·52	Denmark Research Station	Wollongbar Reformer (538)
Travalgan Ice Cream	Jersey	34788	6-2-31	18-5-35	273	15	5,283	5·50	290·47	Robinson Bros.	Banyule Altitude (5793)
Tipperary Gold	A.I.S.	14774	21-4 31	21-10 35	210	16	7,545	3·70	279·09	W. G. Burges	Melba's Re-Echo of Tipperary (2452)
Mokine Empire's Beakaway	Jersey	41069	5-9 30	6-10-34	273	10·5	4,586	5·83	264·44	T. H. Wilding	Twylish Fox of the Valley
Mokine Amy	do.	41067	5-9 30	13-10-34	273	12·5	5,197	5·01	260·32	T. H. Wilding	Mokine Repulse
Stonehill May	do.	34762	4-11 30	14-2-35	273	13·5	4,361	6·12	251·50	C. Kreins	Roelan is Favourite's Butter King (5612)
Ilginup Buttercup	A.I.S.	5195	23-10-30	15-4 35	240	17	6,165	4·05	243·39	E. C. Melville	Tipperary Rob Roy (460)
Grass Vale Golden Cream 6th	Jersey	40079	14-8-31	28 8-35	210	13·5	4,440	5·20	231·75	R. H. Rose	Campanile's Duke of Burekup (7287)
Crantock Lady Primrose	do.		10-6-31	7-7-35	240	6	3,555	6·06	215·46	Mrs. G. H. Burnside	Crantock's Starbright's Montrose
Stonehill Belle	do.	34761	4-11-30	16-11-34	273	5	3,870	4·69	181·78	C. Kreins	Roeland's Favourite Butter King (5612)
Parkview Lady May 23rd	A.I.S.	13236	1-6-31	2-10-35	30	60	1,800	3·59	64·68	W. G. Burges	Daphne's Defiance of Hillview
COWS OVER 3½ YEARS AND UNDER 4 YEARS OLD STANDARD 290 LB. BUTTER-FAT.											
The Wold Easter Daisy	Jersey	34731	5-6-31	27 5-35	273	19·5	8,309	5·79	475·92	L. C. Field	Grantham Easter King (6510)
Parkview Polly II.	A.I.S.	4133	24 2 31	4-11-34	273	21	12,108	3·79	459·18	W. G. Burges	Jean's Monarch of Blacklands (869)
Grantham Easter Fairy	Jersey	34825	18-9-31	1-6-35	273	16·5	8,475	5·55	450·95	J. A. Sears	Greenmount Black Prince (6511)
Swanlea Violet III.	A.I.S.	4297	15-9 30	3-8-34	273	21	10,413	3·86	401·88	P. E. Warburton	Daisy's Gift of Hillview (759)
Nooka May Queen	Jersey	41283	3 5 31	24-2-35	273	24	7,264	5·43	395·21	S. P. Herbert	Spring Park Prince Ragtime (5942)
Greenmount Little Gem	do.	34839	9-6-31	7-6-35	273	14·5	7,109	5·67	394·53	A. J. B. Strempel	Grantham Easter King (6510)
Wooroloo Jean II.	A.I.S.	7739	25-9-31	3-8-35	273	19	8,902	4·40	391·58	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Greenmount Gentle Lass	Jersey	34838	9-8 31	23-8 35	273	11·5	7,475	5·02	375·23	A. J. B. Strempel	Grantham Starbright's King (5796)
Walgett Duchess	do.	42400	20-8-31	23-5-35	273	16	6,993	5·37	371·90	C. J. Cunningham	Campanile's Duke of Burekup (7287)
Muresk Zinia	Guernsey	3294	14-10 31	9-8-35	273	17·5	8,108	4·44	360·29	Muresk Agricultural College	Milton's Victory II. (611)
Wooroloo Sunshine	A.I.S.	5227	13-2 31	2-9-34	273	17·5	6,793	5·07	345·43	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Wingeewah Melba	do.	6732	22-4 31	6-2-35	273	30	8,655	3·87	335·14	A. Della	Regent of The Hill (3038)
Sabina Vale Viola	Jersey		15-9 30	22-6-35	273	15	5,910	5·78	322·82	Sabina Vale Stud Farm	Banyule Lord Silvair (5752)
Radyr Park Clarion Call	do.	45843	5-7-31	26 1-35	273	15	5,505	5·94	321·34	L. Temple	Melrose Clarion (6931)
Muresk Phlox	Guernsey	3292	7 6 31	21 4-35	273	17·5	5,572	5·74	319·95	Muresk Agricultural College	Muresk Menelaus

Colmyn Bluebell	Jersey ...	39318	27-12-31	4-8-35	273	11	6,363	5·00	318·31	C. H. Ironmonger ...	Colmyn Captain Mac (5855)
Woodendale Butterfly ...	do. ...	...	30-8-31	23-5-35	273	15	5,857	5·40	309·90	F. P. Atwell	Werribee Starbright's King (2602)
Denmark Prospers Dinah ...	Guernsey ..	3272	7-12-31	17-7-35	273	8	5,394	5·71	307·84	Denmark Research Station	Koojan Golden Prosper (2283)
Tipperary Gold	A.I.S. ...	14774	21-4-31	25-11-34	273	7	7,626	4·03	307·30	W. G. Burges ...	Melba's Re-echo of Tipperary
Greenmount Marinette	Jersey ...	24840	24-5-31	29-4-35	273	13	6,174	4·93	304·67	A. J. B. Strempel ...	Grantham Starbright's King (5796)
Summerlea Beauty 4th ...	A.I.S. ...	9309	2-8-31	29-6-35	273	12	7,806	3·88	302·71	Dunkley Bros. ...	Victor of Telyarup (2489)
Denmark Prospers Lady ...	Guernsey...	3273	6-12-31	6-8-35	273	10	5,160	5·23	299·95	Denmark Research Station	Koojan Golden Prosper (2283)
Summerlea Red Rose III. ..	A.I.S. ..	14253	24-5-31	24-8-35	273	31	8,148	3·63	296·42	Dunkley Bros. ...	Summerlea Searchlight (972)
Glanavon Mignon	do. ...	5109	22-7-31	28-5-35	273	22	7,746	3·84	293·38	E. T. Thatcher ...	Villiers of Darbalara (2386)
Ilginup Columbine	do. ...	11785	20-9-31	10-9-35	240	13	6,660	4·35	290·01	E. C. Melville ...	Tipperary Pantheon (459)
Denmark Annabel	Guernsey...	3264	17-6-31	6-3-35	273	14	4,842	5·53	267·64	Denmark Research Station	Wollongbar Reformer (538)
Moorlands Fanny	Jersey ..	41097	7-6-31	28-3-35	240	10	4,440	5·71	252·57	Estate late P. Rose ...	Melrose Raliegh (5860)
Woodendale Starbright... ...	do. ...	42578	4-6-31	13-6-35	273	11	4,068	6·48	251·27	F. P. Atwell	Werribee Starbright's King (2602)
Blacklands Pretty Maid 6th ..	A.I.S. ...	9376	25-2-32	13-9-35	240	13	6,165	3·98	245·88	A. E. Grant	Orama of Blacklands (1905)
Lansdowne Butter Queen ...	Jersey ...	...	21-12-31	5-8-35	210	9	3,615	5·83	210·87	B. Langridge ...	Mokine Trooper (7890)
Blacklands Florie 13th ...	A.I.S. ..	9306	2-12-31	18-3-35	210	12	3,795	4·03	153·75	A. E. Grant	Orama of Blacklands (1905)
Claremont Maggie 4th	A.I.S. ..	9931	5-9-31	12-6-35	120	10·5	3,615	4·14	149·79	Claremont Hospital for Insane	Searchlight of Sunnyvale (2302)
Woolawa Homestead Queen ...	Guernsey..	...	20-6-31	27-2-35	150	20	3,090	4·75	147·00	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Colmyn Patty	Jersey ..	39326	5-9-31	6-7-35	30	25·5	875	4·28	37·41	C. H. Ironmonger ...	Colmyn Captain Mac (5855)

COWS OVER 3 YEARS AND UNDER 3½ YEARS OLD—STANDARD 270 Lbs. BUTTER-FAT.

Blacklands Beauty 10th ..	A.I.S. .	9279	2-4-32	8-4-35	273	37	11,473	4·06	466·16	W. G. Burges ...	Fussy's Monarch of Hill View (493)
Brookfields Lady Faith ..	Guernsey.	4062	19-6-32	8-9-35	273	22·5	9,068	4·98	451·53	P. G. Hampshire & Son	Koojan Lord Barclay (1031)
Koojan Bonnie Evelyn	do. ..	3899	7-4-32	13-9-35	273	22	7,761	5·75	446·63	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) 1631)
Westly Lupin	A.I.S. ..	...	28-3-32	1-8-35	273	18	10,714	4·08	428·64	Bayley Bros. ...	Telyarup Duke (956)
Sabina Vale Countess	Jersey ...	...	27-4-32	7-7-35	273	19	7,452	5·81	424·33	Sabina Vale Stud Farm	Bellefaire Seaborn Successor (imp.) (6824)
Fairfield Royal Lu-Lu	A.I.S. ...	...	22-3-32	7-4-35	273	25	11,185	3·68	411·94	W. G. Burges ...	Kinsman of Greyleigh (111)
Koojan Ace's Mignonette ..	Guernsey	3898	23-4-32	6-9-35	273	16	7,083	5·78	410·60	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Tabbagong Dove 8th	A.I.S. ..	7511	19-12-31	24-5-35	273	28	9,174	4·17	380·39	W. G. Burges ...	Parkview Reward II. (260)
Glanavon Penelope	A.I.S. ..	2366	21-8-30	4-11-34	273	23	8,769	4·32	379·09	D. Bevan & Sons ...	Villiers of Darbalara (2386)
The Wold Starbright Grey ..	Jersey ...	42215	9-5-32	2-7-35	273	16·5	6,620	5·51	365·39	L. C. Field	Lonswood Lord Grey (7291)
Colmyn Snowflake	do. ..	39327	10-11-31	6-4-35	273	16·5	6,453	5·47	352·76	C. H. Ironmonger ...	Rye Duke of Glen Iris (1994)
Glanavon Gold	A.I.S. ...	10925	25-6-32	7-8-35	273	19	8,487	4·10	346·67	D. Bevan & Sons ...	Villiers of Darbalara (2386)
Sabina Vale Ruby's Lass ...	Jersey ...	50538	5-4-32	14-9-35	273	15	6,105	5·63	344·11	Sabina Vale Stud Farm	Ruby's Beau (imp.) (7963)
Sabina Vale Lotus	Jersey ...	4611	16-4-32	4-6-35	273	17·5	6,338	5·54	343·12	Sabina Vale Stud Farm	Banyule Airo (5751)
Nooka Rosebud	do. ...	45460	7-9-31	1-3-35	273	18·5	6,347	5·25	333·18	S. P. Herbert ...	Spring Park Prince Ragtime (5942)
Muresk Duchess	Guernsey	4724	2-8-32	9-8-35	273	17·5	5,828	5·61	327·07	Muresk Agricultural College	Denmark Empire's Chief
Koojan Ace's Waterwave ...	do. ...	4337	23-8-32	2-9-35	273	16	6,138	5·07	311·56	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Grass Vale Golden Cream 7th ...	Jersey ...	44182	19-7-32	14-9-35	273	11	5,682	5·45	309·77	R. H. Rose	Banyule Silvermine's Twylish (7600)
Stonehill Lady	do. ...	42015	8-10-31	2-11-35	273	13·5	4,870	6·33	308·48	C. Kreins	Roeland's Favourite's Butter King (5672)
Wooroloo Betty III.	A.I.S. ...	7735	17-12-31	10-5-35	278	13	6,796	4·50	304·15	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Blacklands Modesty III. ...	do. ...	9367	20-5-32	19-8-35	273	17	7,685	3·94	300·79	A. E. Grant	Emperor of Blacklands (947)
Radyr Park Dorothy	Jersey ...	45844	27-7-31	15-11-34	240	10	5,670	5·16	292·44	L. Temple	Melrose Clarion (6931)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
COWS OVER 3 YEARS AND UNDER 3½ YEARS OLD—STANDARD 270 Lbs. BUTTER-FAT.						lb.	lb.	%	lb.		
Blacklands Rosette II. ...	A.I.S. ...	9389	4–5 32	1–4 35	273	18	7,014	4·11	288·48	D. Bevan & Sons ...	Blacklands Major (369)
Tirano Primrose	A.I.S. ...	...	25–3–32	12–3–35	273	21·5	6,769	4·21	285·37	A. Della	Pine Creek Banker
Moorlands Grace	Jersey ...	45241	3–5–32	5–5–35	273	7·5	4,688	6·23	283·27	Estate late P. Rose ...	Melrose Sultan (6930)
Denmark Golden Marie ...	Guernsey	3873	26–4–32	28–7–35	273	9	5,157	5·48	282·83	Denmark Research Station	Koojan Golden Prosper (2283)
Moorlands Glory	Jersey ...	45238	23–4–32	5–5–35	240	10	5,055	5·73	282·15	Estate late P. Rose ...	Melrose Sultan (6930)
Nooka Bright Jane	do. ...	49855	18–6–32	25–7–35	240	14·5	5,520	5·00	271·00	S. P. Herbert ...	Spring Park Prince Ragtime (5942)
Ilginup Dimple	A.I.S. ...	11791	2–5–32	20–6–35	240	8	7,425	3·64	264 99	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Wooroloo Pearl	do. ...	7746	12–12–31	22–4–35	273	10·5	5,507	4·86	263·99	Wooroloo Sanatorium Farm	Tipperary Persimmon (471)
Westly Polly	do. ...	15141	21–5 32	17–9–35	273	12	6,756	3·84	261·65	Bayley Bros. ...	Telyarup Duke (956)
Grass Vale Lady Fowler 16th...	Jersey ...	44183	2–9 32	8–10–35	273	16	4,983	5·22	260·17	R. H. Rose	Banyule Silvermine's Twylish (7600)
Glanavon Vimy	A.I.S. ...	6730	21–9–31	6–12–34	273	20	7,185	3·52	252·60	E. T. Thatcher ...	Villiers of Darbalara (2386)
Wooroloo Lovely	do. ...	7742	20–10–31	23–1–35	273	16	5,628	4·40	247·75	Wooroloo Sanatorium Farm	Tipperary Persimmon (471)
Denmark Rosebud	Guernsey	3876	14–3–32	2–7–35	273	10	4,170	5·64	235·39	Denmark Research Station	Wollongbar Macquarrie
Colmyn Eileen	Jersey ...	43463	8–10 32	12–10–35	273	16·5	6,125	3·83	234·82	C. H. Ironmonger ...	Rye Duke of Glen Iris (1994)
Ilginup Dairymaid	A.I.S. ...	11788	4–4–32	18 6–35	240	7·5	6,660	3·87	224·89	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Wooroloo Kitty	A.I.S. ...	...	28–4–31	3–9–34	210	5·5	5,040	4·60	206·91	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Ilginup Dewdrop	do. ...	11790	12–4–32	20–5–35	210	18·5	5,100	3·65	184·14	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Denmark Prosper's Velvet ...	Guernsey	3875	23–3–32	19 6–35	273	7	3,681	5·13	176·98	Denmark Research Station	Koojan Golden Prosper (2283)
Woodendale Girlie's Starbright	Jersey ...	46757	31–8 31	22–10–34	210	8·5	4,435	3·95	175·65	F. P. Atwell	Werribee Starbright's King
Lansdowne Makanara	do. ...	...	4–7–32	22–7 35	210	8	2,910	6·01	174·87	B. Langridge ...	Colmyn Captain Mac (5855)
Wooroloo Margaret II. ...	A.I.S. ...	7743	28–11 31	22–2–35	150	16	3,247	4·24	138·01	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Colmyn Mirina	Jersey ..	39324	13–5 32	29 6 35	30	27	810	4·51	36·54	C. H. Ironmonger ...	Rye Duke of Glen Iris (1994)
COWS OVER 2½ YEARS AND UNDER 3 YEARS OLD—STANDARD 250 Lb. BUTTER-FAT.											
Blacklands Miss Ettie III. ...	A.I.S. ...	9354	15–5–32	27–1 35	273	21	8,793	4·03	354·62	W. G. Burges ...	Emperor of Blacklands (947)
Nooka Vanity II.	Jersey ...	...	1–8–32	18–2–35	273	19	6,035	5·06	339·65	S. P. Herbert ...	Spring Park Prince Ragtime (5942)
Claremont Belle 11th	A.I.S. ...	9904	4–5 32	5–11 34	273	26·5	8,382	4·00	335·73	Claremont Hospital for Insane	Claremont Herdsman (968)
Nooka Daisy Queen	Jersey ...	45456	7–11–32	22 7–35	240	14·5	5,985	5·35	320·07	S. P. Herbert ...	Nooka Carnation King (8214)
Sabina Vale Silvermine... ...	do. ...	...	29–3 32	4–10–34	273	19	5,907	5·30	312·75	Sabina Vale Stud Farm	Banyule Lord Silvair (5752)
Mereworth Vanilla Queen ..	do. ...	40998	14–5–32	22 4–35	273	16	5,688	5·44	309·34	B. Langridge ...	Grantham Starbright's Northwood (5941)
Moorlands Glide	do. ...	45237	5–8–32	25–3–35	273	5·5	5,551	5·57	309·07	Estate late P. Rose ...	Melrose Clarion (6931)
Greenmount Charming Queen ...	do. ...	40099	9–6 32	7–3 35	273	17	5,706	5·36	306·04	A. J. B. Strempel ...	Grantham Easter King (6510)

Grantham Easter Pride ...	Jersey ...	44181	31 10-32	26-7-35	240	14	5,415	5·61	303·57	J. A. Sears	Greenmount Black Prince (6511)
Blacklands Fairy 12th ...	A.I.S. ...	9301	6 5-32	22-12-34	273	25	7,500	3·99	299·56	D. Bevan & Sons ...	Orama of Blacklands (1905)
Blacklands Fortune 7th ...	do. ...	9316	11-7-32	7 3 35	273	13·5	7.165	4·10	295·65	W. G. Burges ...	Orama of Blacklands (1905)
Denmark Rose Pearl 6th ...	Guernsey...	3282	18 12 31	17 10 34	273	13	5,409	5·32	286·97	Denmark Research Station	Wollongbar Reformer (538)
Crantock's Starbright Napoleonette	Jersey ...	...	27 11 32	4 8 35	273	12	5,241	5·40	283·55	Mrs. G. H. Burnside ...	Crantock's Blonde's Napoleon
Drakesbrook Dolly	Guernsey...	4141	2-12-32	19-10-34	273	16·5	5,905	4·80	283·51	P. G. Hampshire & Son	Koojan Lord Barclay (1031)
Denmark Amy	do. ...	4114	27-6-32	3-1-35	273	10	4,687	6·04	283·26	Denmark Research Station	Wollongbar Reformer (538)
Muresk Lady Fayre	do. ...	4729	20-9 32	8-4-35	273	19	5,787	4·75	274·93	Muresk Agricultural College	Triumph of Wollongbar (513)
Sabina Vale Pansy	Jersey ...	...	23 11-32	21-6-35	273	13·5	5,209	5·18	268·98	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (18782)
Tirano Charming Dinah ...	A.I.S. ...	...	28 6-32	1-3-35	273	27	7,526	3·54	266·24	A. Della	Bryn-y-mar Charmer (266)
Radyr Park Laddie's Estrellita	Jersey ...	45846	16-7-32	12-5-35	273	12	4,289	6·09	261·04	L. Temple	Graceful Lad of Greenmount
Denmark Orangebud	Guernsey...	4123	9-8-32	8 5-35	273	17	4,971	5·04	250·43	Denmark Research Station	Koojan Golden Prosper (2283)
Blacklands Graceful 7th ...	A.I.S. ...	9318	24-7-32	11-6 35	273	18·5	6,236	3·80	236·42	A. E. Grant	Orama of Blacklands (1905)
Blacklands Miss Tottie 4th ...	do. ...	9365	12-4 32	21-3-35	273	7·5	5,137	4·36	224·32	A. E. Grant	Orama of Blacklands (1905)
Moorlands Guitar	Jersey ...	49634	17 7-32	4-7-35	210	6	4,185	5·43	217·71	Estate late P. Rose ...	Melrose Liberty (7973)
Claremont Treasure 7th ...	A.I.S. ...	...	14-5-32	12 5 35	240	14	6,255	3·50	216·06	A. E. Grant	Claremont Elector (446)
Radyr Park Dorothy II. ...	Jersey ...	45845	24-7-32	23-7-35	273	5	3,780	5·50	207·98	L. Temple	Graceful Lad of Greenmount (7292)
Moorlands Girlie	do. ...	45235	6-5-32	24-3-35	240	11	3,450	5·75	198·45	Estate late P. Rose ...	Melrose Sultan (6930)
Moorlands Glitter	do. ...	...	14-8-32	22-4-35	210	12·5	3,203	5·09	163·24	Estate late P. Rose ...	Melrose Sultan (6930)
Beauna Vista Jock's Tiny ...	A.I.S. ...	...	25-9-32	15-9-35	90	40	4,110	3·57	145·23	D. Bevan & Sons ...	Beauna Vista Jack (212)
Nooka Red Rose	Jersey ...	...	28-12-32	1-9-35	180	9	2,663	5·04	134·28	S. P. Herbert ...	Pella O.K. (9913)
Radyr Park Starbright Solo ...	do. ...	...	15-1-33	4-12-35	120	7	1,560	4·89	76·31	L. Temple	Graceful Lad of Greenmount

COWS UNDER 2½ YEARS OLD—STANDARD 230 Lbs. BUTTER-FAT.

Koojan Ace's Jewel	Guernsey	4333	19-2-33	5-7-35	273	18·5	7,335	5·57	388·93	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Koojan Pretty Polly	do. ...	4341	13-9-32	15-1-35	273	27	7,761	4·71	365·22	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Wooroloo Duchess II.	A.I.S. ...	15324	15-8-32	27-10-34	273	26	8,781	4·02	353·16	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Claremont Biddy 24th	do. ...	9909	5-7 33	12 8-35	273	20	8,070	4·37	353·08	Claremont Hospital for Insane	Tipperary Virginia's Re-Echo
Wooroloo Red Rose V. ...	do. ...	15342	16-12-32	20-2-35	273	23·5	7,290	4·78	348·77	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Grantham Easter Lily	Jersey ...	...	21-8 33	3-7-35	273	14	5,592	6·13	340·32	J. A. Sears	Greenmount Black Prince (6511)
Greenmount Bonetienne's Twinkette	do. ...	44202	6-8-33	26-8-35	273	14·5	6,044	5·61	339·31	A. J. B. Strempel ...	Bellefaire Bonaparte's Bonetienne (9224)
Wooroloo Wing Wing 4th ...	A.I.S. ...	7749	11 5-32	29-10-34	273	20	7,257	4·65	337·14	Wooroloo Sanatorium Farm	Triumph of Pine Creek (2515)
Glanavon Vida II.	do. ...	...	25-5-33	6 9-35	273	18	7,374	4·50	331·40	D. Bevan & Son ...	Glanavon Nimrod (437)
The Wold Starbright Grey II. ...	Jersey ...	46430	17-4-33	8-10-35	273	23·5	7,286	4·54	330·68	L. C. Field	Lonswood Lord Grey (7291)
Greenmount Bonetienne's Ettenette	do. ...	44198	23-9-32	18-11 34	240	24	5,580	5·87	327·86	A. J. B. Strempel ...	Bellefaire Bonaparte's Bonetienne (9224)
Claremont Beanie 6th	A.I.S. ...	9902	21-10-32	17-12-34	273	16	8,028	4·07	326·87	Claremont Hospital for Insane	Claremont Herdsman (968)
Tabbagong Dove II.	do. ...	14421	22 7-33	7-9 35	273	21	8,298	3·93	326·10	W. G. Burges ...	Parkview Reward II.
Claremont Rachel 8th ...	do. ...	9942	14-5-33	19-7-35	273	25·5	7,997	4·06	318·67	Claremont Hospital for Insane	Tipperary Daphne's Boy
Walgett Handsome Girl II. ...	Jersey ...	51062	12-11 32	5 3-35	273	19·5	5,503	5·67	312·29	C. J. Cunningham ...	Mokine Centenary (7595)
Greenmount Bonetienne's Tomboy	do. ...	44199	17-4-33	14-7 35	273	13	5,064	6·05	306·52	A. J. B. Strempel ...	Bellefaire Bonaparte's Bonetienne (7224)

HERD TESTING—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
						lb.	lb.	%	lb.		
COWS UNDER 2½ YEARS OLD—STANDARD 230 LBS. BUTTER-FAT—*continued.*											
Claremont Star 10th	A.I.S. ...	9946	16-10-32	5-11-34	273	15·5	6,662	4·83	304·85	Claremont Hospital for Insane	Tipperary Virginia's Re-Echo (970)
Glanavon Jeanette	do. ...	...	24-8-33	11-8-35	273	16	6,978	4·30	299·49	D. Bevan & Sons ...	Villiers of Darbalara (2386)
Walgett Handsome Girl III. ...	Jersey ...	51063	12-11-32	7-4-35	273	20·5	5,537	5·53	297·34	C. J. Cunningham ...	Mokine Centenary (7595)
Grass Vale Lady Fowler 17th ...	do. ...	48536	6-5-33	12-9-35	273	16·5	5,660	5·23	295·91	R. H. Rose	Banyule Silvermine's Twylish (7600)
Greenmount Bonetienne's Twinkle	do. ...	44201	24-3-33	17-1-35	273	24·5	5,296	5·50	291·57	A. J. B. Strempel ...	Bellefaire Bonaparte's Bonetienne (7224)
The Wold Daisy Grey II. ...	do. ...	...	28-3-33	26 4-35	273	16·5	5,315	5·47	290·75	L. C. Field	Lonswood Lord Grey (7291)
Claremont Rachel 7th ...	A.I.S. ...	9941	26-11-32	11-1-35	273	21·5	6,529	4·42	288·85	Claremont Hospital for Insane	Tipperary Virginia's Re-Echo (970)
Denmark Prosper's Rosa ...	Guernsey...	4127	27-12-32	21-4-35	273	16	5,223	5·52	288·70	Denmark Research Station	Koojan Golden Prosper (2283)
Wooroloo Matilda	A.I.S. ...	15336	2-3-33	27 8-35	273	16	5,763	5·00	287·44	Wooroloo Sanatorium	Tipperary Persimmon (471)
Woodendale Princess	Jersey ...	...	14-6-33	22-5-35	273	13·5	4,961	5·70	282·00	F. P. Atwell	Grantham Easter King (6510)
Blackland's Ettie 9th	A.I.S. ...	9298	24-9-32	25-10-34	273	21	6,603	4·26	281·56	D. Bevan & Sons ...	Parkview Limelight (370)
Koojan Ace's Pixie	Guernsey	4336	11 4 33	5 4-35	273	18·5	5,799	4·85	281·54	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Travalgan Lady Mint III. ...	Jersey ...	46485	20-12-32	4-4-35	273	17	4,836	5·81	281·01	Robinson Bros. ...	Banyule Altitude (5793)
Tipperary Lady May	A.I.S. ...	14777	19-9-33	8-10-35	273	20	7,635	3·67	280·59	W. G. Burges ...	Parkview Rosy's Monarch
Claremont Cleggit 6th ...	do. ...	9918	15-12-32	7-1-35	273	21·5	6,634	4·18	277·39	Claremont Hospital for Insane	Claremont Herdsman (968)
Denmark Golden Dawn ...	Guernsey...	4118	9-1-33	13-3-35	273	17	4,401	6·29	277·02	Denmark Research Station	Koojan Golden Prosper (2283)
Westly Pearl	A.I.S. ...	15140	19 2-33	28 2-35	273	28	6,089	4·53	276·26	Bayley Bros. ...	Telyarup Duke (956)
Blackland Cowslip 6th	do. ...	9288	4-12-32	7-12-34	273	21	6,393	4·29	274·05	D. Bevan & Sons ...	Emperor of Blacklands (947)
Blackland's Poppy 5th ...	do. ...	9372	13-10-32	4-12-34	273	25	6,990	3·87	270·94	D. Bevan & Sons ...	Blacklands Major (369)
Sabina Vale Blossom	Jersey ...	50536	28-11 32	22 5-35	273	12·5	4,748	5·86	270·65	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Iginup Debutante	A.I.S. ...	11789	11- 8-32	10 10-34	273	14	5,832	4·59	169·27	E. C. Melville ...	Tipperary Pantheon (459)
Muresk Beauty	Guernsey	4716	21-4 33	12-7-35	273	16	5,643	4·8	269·44	P. G. Hampshire & Son	Minnamurra Plaintiff (1318)
Muresk Dessie	do. ...	4722	20-4-33	15 5-35	273	14·5	5,234	5·06	268·15	Muresk Agricultural College	Triumph of Wollongbar (513)
Walgett Water Lily	Jersey ...	51066	28-8 33	4-5-35	273	15	5,175	5·18	265·99	C. J. Cunningham ...	Mokine Centenary (7595)
Sabina Vale Silvermine III. ...	Jersey ...	50540	25-5-33	18 5-35	273	14	4,242	6·13	264·49	Sabina Vale Stud Farm	Glen Iris Matilda's Lord (9491)
Muresk Rosebud	Guernsey	4732	4-7-33	26-8-35	273	14	5,277	5·00	264·21	Muresk Agricultural College	Minnamurra Plaintiff (1318)
Moorlands Hyacinth	Jersey ...	...	26-5-33	14-6-35	240	10·5	4,867	5·69	264·10	Estate late P. Rose ...	Melrose Liberty (7973)
Muresk Jessie	Guernsey	4727	15-5-33	20-5 35	273	15	5,325	5·04	262·56	Muresk Agricultural College	Triumph of Wollongbar (513)
Claremont Cleggit 5th	A.I.S. ...	9917	31-8-32	28 1-35	273	18	6,054	4·33	262·44	Claremont Hospital for Insane	Claremont Elector (446)
Grass Vale Golden Cream 10th	Jersey ...	48535	7-10-33	23-10-35	273	12	5,406	4·81	260·36	R. H. Rose	Banyule Silvermine's Twylish (7600)
Lansdowne Lillian	Guernsey	4363	23-4-33	6-9-35	273	9	5,472	4·73	258·79	J. R. Giles	Koojan Ace's Advocate (2272)
Glanavon Dulcie	A.I.S. ...	10924	13 2-33	29-10-34	273	18	6,114	4·17	255·37	D. Bevan & Sons ...	Villier's of Darbalara (2386)
Mereworth Starbright's Vanilla	Jersey ...	49510	1-6 33	2-7-35	273	8	4,659	5·52	253·16	B. Langridge ...	Grantham Starbright's Northwood (5941)

Moorland's Happy	Jersey ...	...	30-4-33	10-6-35	240	8·5	4,770	5·04	252·33	Estate late P. Rose ...	Melrose Liberty (7973)
Mokine Empire's Lily 17 ...	do. ...	49581	20-9-32	6-10-34	273	14·5	5,368	4·71	252·14	T. H. Wilding ...	Juadine Sunshine
Wooroloo Rosella	A.I.S. ...	15345	1-11-32	8-10-34	273	13·5	5,020	4·96	248·97	Wooroloo Sanatorium Farm	Tipperary Persimmon (471)
Colmyn Daisy	Jersey ...	47679	25-10-33	6-9-35	273	8·5	4,616	5·40	248·90	C. H. Ironmonger ...	Colmyn Captain Mac (5855)
Claremont Biddy 21	A.I.S. ...	9907	18-10-32	5-11-34	273	12	6,201	4·20	248·27	Claremont Hospital for Insane	Claremont Elector (446)
Woodendale Easter Lily ...	Jersey ...	...	17-6-33	20-5-35	273	14	5,562	4·64	245·68	F. P. Atwell	Grantham Easter King (6510)
Blackland's Red Queen 8th ...	A.I.S. ...	9386	16-10-32	12-3-35	273	12	6,396	3·80	244·54	A. E. Grant	Orama of Blacklands (1905)
Blackland's Daphne 6 ...	do. ...	9290	2-11-32	29-3-35	240	10·5	5,880	4·02	236·25	A. E. Grant	Fussy's Monarch of Hillview (493)
Iginup Dahlia	do. ...	11787	21-9-32	20-10-34	273	10·5	5,836	4·04	235·77	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Denmark Pride	Guernsey ...	4124	16-2-33	20-4-35	273	13	4,074	5·78	235·43	Denmark Research Station	Koojan Golden Prosper (2283)
Claremont Beauty 10th ...	A.I.S. ...	...	8-3-33	25-5-35	273	23	5,964	4·07	234·04	Claremont Hospital for Insane	Tipperary Daphne's Boy (449)
Colmyn Bonnie	Jersey ...	43461	7-6-33	22-5-35	273	9	4,422	5·35	231·08	C. H. Ironmonger ...	Colmyn Captain Mac (5855)
Blackland's Lady Thelma ...	A.I.S. ...	9342	1-11-32	17-3-35	273	12·5	5,517	4·17	230·37	A. E. Grant	Parkview Limelight (370)
Colmyn Bubbles	Jersey ...	47678	21-9-33	1-7-35	273	10·5	4,907	4·67	228·54	C. H. Ironmonger ...	Colmyn Captain Mac (5855)
Tabbagong Beauty 27	A.I.S. ...	14413	12-8-33	15-8-35	273	11	5,313	4·30	228·42	W. G. Burges ...	Tabbagong Regent
Tipperary Polly	do. ...	14782	30-7-33	23-8-35	273	8·5	5,831	3·91	228·08	W. G. Burges ...	Parkview Rosy's Monarch
Lansdowne Cream Lass ...	Guernsey...	4354	7-10 33	2-9-35	273	9	4,107	5·51	226·27	J. R. Giles	Koojan Ace's Advocate (2272)
Moorlands Hopeful	Jersey ...	...	12 6 33	17-6 35	210	9·5	4,695	4·84	221·73	Estate late P. Rose ...	Melrose Liberty (7973)
Moorland's Hydrant	do. ...	...	5-5 33	15 6 35	210	10	4,350	5·16	221·43	Estate late P. Rose ...	Melrose Liberty (7973)
Blackland's Daphne 7th ...	A.I.S. ...	9291	18-10-32	19 3 35	273	4·5	5,863	3·76	220·32	A. E. Grant	Fussy's Monarch of Hillview (493)
Nooka Jewel	Jersey ...	49857	27-1-34	27 5 35	273	12	4,131	5·24	217·20	S. P. Herbert ...	Mokine Tartan
Mokine Empire's Lily 18th ...	do. ...	49582	27-11-32	4 10-34	273	11·5	4,207	5·15	216·88	T. H. Wilding ...	Mokine Repulse
Denmark Prosper's Mona ...	Guernsey...	4126	2-2 33	22-3-35	273	18	4,614	4·52	216·52	Denmark Research Station	Koojan Golden Prosper (2283)
Denmark Red Rose 9th ...	do. ...	4128	13 1 33	24 3 35	180	16	3,495	6·17	215·82	Denmark Research Station	Koojan Golden Prosper (2283)
Mereworth Goldington Buttercup	Jersey ...	49506	1-6-33	8 7 35	240	6·5	3,217	6·54	210·33	B. Langridge ...	Grantham Starbright's Northwood (5941)
Moorland's Hermia	do. ...	...	9-5-33	14 6-35	240	9·5	3,750	5·31	209·34	Estate late P. Rose ...	Melrose Clarion (6931)
Blackland's Charmer III. ...	A.I.S. ...	...	25-12-32	28-1-35	273	14	4,662	4·32	199·30	D. Bevan & Sons ...	Emperor of Blacklands
Stonehill Carnation's Lady ...	Jersey ...	...	2-6-33	16 7 34	240	9	3,780	5·02	189·90	C. Kreins	
Iginup Echo	A.I.S. ...	...	22-4-33	13-10-35	240	7	4,905	3·85	188·93	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Iginup Ena	do. ...	...	15-1-33	25-10 34	273	10	4,717	3·95	186·17	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Iginup Echo	do. ...	...	22 4-33	14 10 34	273	7·5	4,469	4·16	185·79	E. C. Melville ...	Tipperary Melba's Emblem II. (989)
Yanget Pansy	do. ...	5154	25-3-33	22-2-35	273	9·5	4,559	4·16	185·38	A. E. Grant	Yanget Pet's Re-Echo (459)
Mereworth Starbright's Queen III.	Jersey ...	49509	5-8-33	11 7-35	240	7·5	3,570	5·20	185·01	B. Langridge ...	Grantham Merry Starbright (9547)
Moorland's Hester	do. ...	...	5-8-33	15-6-35	240	6·5	3,870	5·07	183·57	Estate late P. Rose ...	Melrose Liberty (7973)
Wooroloo Fairy	A.I.S. ...	15328	7-8-33	27-8-35	273	7	4,221	4·26	179·76	Wooroloo Sanatorium Farm	Wooroloo Prince
Denmark Golden Lass	Guernsey...	4120	12-12-32	27-3-35	180	13	2,820	5·34	150·75	Denmark Research Station	Koojan Golden Prosper (2283)
Mereworth Starbright's Princess	Jersey ...	49508	2-10-33	19-7-35	180	8	2,220	6·11	135·66	B. Langridge ...	Grantham Merry Starbright (9547)
Radyr Park Laddie's Princess ...	do. ...	...	3-8-33	6-8 35	210	4·5	2,355	5·61	132·18	L. Temple	
Grass Vale Noramine	do. ...	48537	17-11-33	6-11-35	150	10·5	2,640	4·90	128·93	R. H. Rose	Banyule Silvermine Twylish (7600)
Denmark Golden Flirt	Guernsey	4119	28-1-33	25-3-35	180	10	2,100	5·53	116·61	Denmark Research Station	Koojan Golden Prosper (2283)
Claremont Cleggitt 7th ...	A.I.S. ...	9919	7-8-33	10-11-35	120	17·5	2,640	4·16	103·77	Claremont Hospital for Insane	Tipperary Virginia's Re-Echo (970)
Yanget Favourite 4th	do. ...	15411	27-2-33	2-5-35	150	17·5	2,505	4·03	100·98	A. E. Grant	Yanget Lucky Boy (978)
Claremont Treasure 8th ...	do. ...	9948	21-8-33	7-11-35	120	14·5	2,505	3·89	90·63	Claremont Hospital for Insane	Tipperary Daphne's Boy (449)

HERD TESTING.—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
COWS UNDER 2½ YEARS OLD—STANDARD 230 LB. BUTTER-FAT—*continued.*						lb.	lb.	%	lb.		
Sabina Vale Daisy	Jersey ...	...	11-7-33	31-10-35	120	10	1,875	4·47	83·91	B. Langridge ...	Banyule Ettric (9200)
Claremont Cocky 8th	A.I.S. ...	...	17-11-32	1-4-35	90	...	1,905	4·38	80·82	Claremont Hospital for Insane	Tipperary Virginia's Re-Echo (970)
Radyr Park Starbright's Clarion	Jersey ...	...	26-3-34	14-8-35	120	11	1,320	6·00	79·53	L. Temple	
Wooroloo Girl	A.I.S. ...	15332	2-2-33	26-4-35	90	15	1,695	4·47	75·75	Wooroloo Sanatorium Farm	Tipperary Persimmon (471)
Yanget Royal Lady	do. ...	15417	21-9-33	29-8-35	60	21·5	1,545	3·70	57·58	A. E. Grant	Glanavon Defender (959)
Wooroloo Mossrose III. ...	do. ...	15340	25-3-33	7-9-35	60	17·5	1,155	3·75	44·04	Wooroloo Sanatorium Farm	Tipperary Persimmon (471)
Muresk Queen	Guernsey...	4731	27-9-33	19-5-35	60	14·5	915	4·70	43·41	Muresk Agricultural College	Minnamurra Plaintiff.

TABLE III.

THE OFFICIAL AUSTRALIAN PURE BRED DAIRY CATTLE PRODUCTION RECORDING SCHEME.

SUPPLEMENT.

Cows which completed Test 16th May to 30th June, 1935.

MATURE COWS (OVER 5 YEARS OLD)—STANDARD 350 LBS. BUTTER-FAT.											
Spring Park Starbright's Queen	Jersey ...	24901	16-3-28	4-9-34	273	24	10,062	6·03	606·81	Robinson Bros. ...	Prince Marinora of Grass Vale (4582)
Yallah Farm Maggie II. ...	A.I.S. ...	1272	30-8-28	20-9-34	273	35	14,295	3·15	549·88	W. G. Burges ...	Fussy's Favourite of Park View (2149)
Gold of Eastview	do. ...	10940	1-5-26	29-8-34	273	24·5	13,038	3·85	502·16	D. Bevan & Sons ...	Mariner of Greyleigh (587)
Newry Lady Freda	Guernsey...	2719	13-9-28	14-9-34	273	20	8,580	5·49	470·83	G. E. Scott	Koojan Mac (596)
Muresk Rose	do. ...	2156	9-5-28	17-8-34	273	22	8,406	5·50	461·48	Muresk Agricultural College	Triumph of Wollongbar (513)
Claremont Fancy II.	A.I.S. ...	2401	25-4-28	2-8-34	273	30·5	11,101	3·88	430·85	Claremont Hospital for Insane	Telyarup Prince of Claremont (2352)
Grantham Lady Fowler III. ...	Jersey ...	24933	7-7-28	29-7-34	273	17	7,486	5·64	421·95	J. A. Sears	Merry King of Greenmount (4306)
Muresk Primrose	Guernsey...	2527	3-3-29	9-8-34	273	23·5	7,501	5·50	415·66	Muresk Agricultural College	Triumph of Wollongbar (513)
Wingeewah Kate III.	A.I.S. ...	1535	20-3-29	4-9-34	273	26	11,328	3·27	370·86	A. Della	Daphne's Defiance of Hillview (found)
Brackenhurst Gibson's Lass ...	do. ...	2514	22-9-27	12-8-34	273	28·5	9,405	3·93	370·19	P. E. Warburton ...	Triumph of Berry (1882)
Minnamurra Eleanor	Guernsey...	2607	13-8-29	17-8-34	273	23	7,839	4·60	360·67	Muresk Agricultural College	Caramana Favour (652)
Gold 11th of Raleigh	A.I.S. ...	17507	16-10-27	20-9-34	210	24	8,745	4·05	354·54	D. Bevan & Sons ...	Royal Standard of Darbalara (2908)
Gwen II. of Eastview	do. ...	18337	1-9-28	4-8-34	273	24	10,287	3·40	352·59	A. E. Grant	Mariner of Greyleigh (587)
Claremont Polly II.	do. ...	2419	19-1-29	12-10-34	273	7	8,485	3·68	311·98	Bayley Bros. ...	Clinker of Claremont (2456)
COWS OVER 4½ AND UNDER 5 YEARS—STANDARD 330 LBS. BUTTER-FAT.											
Mokine Empire's Twylish ...	Jersey ...	34842	30-12-29	12-9-34	240	8·5	3,165	4·51	142·59	T. H. Wilding ...	The Valley Twylish Fox.

COWS OVER 4 AND UNDER 4½ YEARS—STANDARD 310 LBS. BUTTER-FAT.

Colmyn Cellene Rye	Jersey ...	34751	10–3–30	27–8–34	273	21	8,163	5·09	415·71	C. H. Ironmonger ...	Colmyn Captain Mac (5855)
Claremont Whitby Maid 11th ...	A.I.S. ...	8332	2–6–30	29–8–34	240	31	10,935	4·46	402·79	Claremont Hospital for Insane	Claremont Elector (446)
Wingeewah Winnie 7th ...	do. ...	4395	20–3–30	13–8–34	273	21·5	9,139	3·56	325·58	A. E. Grant	Daphne's Defiance of Hillview (Found.)
Springhurst Belladonna 4th ...	Jersey ...	33644	12–2–30	7–8–34	273	13·5	6,160	4·62	285·04	Sabina Vale Stud Farm	Starbright's Prince of Glen Iris (3345)
Hillview Fussy 34th	A.I.S. ...	4496	3–9–30	19–9–34	273	23	7,246	3·44	247·97	A. E. Grant	Limelight of Hillview

COWS OVER 3½ AND UNDER 4 YEARS—STANDARD 290 LBS. BUTTER-FAT.

Koojan Bo-Peep	Guernsey...	3542	26–2–31	3–9–34	273	24	9,392	4·52	425·26	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Brookfield's Princess	do. ...	3712	15–12–30	27–9–34	273	20·5	7,681	5·34	410·35	G. E. Scott	Minnamurra Betty's Prince (524)
Colmyn Winnie Rye	Jersey ...	34757	5–3–31	1–9–34	273	24	7,437	5·43	404·23	C. H. Ironmonger ...	Rye Duke of Glen Iris (1994)
Claremont Beanie 4th	A.I.S. ...	8324	11–8–30	2–8–34	273	26	10,308	3·91	402·63	Claremont Hospital for Insane	Claremont Forrester (448)
Blackland's Jeanette 7th ...	do. ...	9324	1–1–31	24–8–34	273	20	9,240	4·02	371·94	W. G. Burges ...	Fussy's Monarch of Hillview (493)
Woodstock Lady Morden ...	Guernsey...	3328	27–11–30	26–8–34	273	18	6,834	4·56	311·65	A. G. Haynes ...	Homestead Ace (imp. U.S.A.) (1631)
Denmark Rose Pearl V. ...	do. ...	3281	20–8–30	22–7–34	273	8	4,944	6·30	289·54	Denmark Research Station	Reformer of Wollongbar (538)

COWS OVER 3 AND UNDER 3½ YEARS—STANDARD 270 LBS. BUTTER-FAT.

Parkview Lady May 23rd ...	A.I.S. ...	13236	1–6–31	31–8–34	273	30	11,805	3·67	432·67	W. G. Burges ...	Daphne's Defiance of Hillview (Found.)
Tabbagong Fairy 8th	do. ...	7514	14–7–31	30–8–34	273	21	10,233	4·10	418·79	W. G. Burges ...	Parkview Renard II. (260)
Crantock Cream Lass	Jersey ...	43542	7–6–31	15–9–34	273	6	5,070	6·05	306·67	Mrs. G. H. Burnside...	Crantock Starbright Napoleon
Grass Vale Golden Cream V. ...	do. ...	40078	14–8–31	9–9–34	273	13·5	5,940	4·96	294·82	R. H. Rose	Campanile's Duke of Burekup
Fairfield Velvet	A.I.S. ...	6477	5–9–31	26–8–34	273	18	7,569	3·59	271·89	P. E. Warburton ...	Kinsman of Greyleigh (111)
Ilginup Columbine	do. ...	11785	20–9–31	26–10–34	210	10·5	5,610	4·60	258·06	E. C. Melville ...	Tipperary Pantheon (459)

COWS OVER 2½ AND UNDER 3 YEAYS OLD—STANDARD 250 LBS. BUTTER-FAT.

Colmyn Buttercup	Jersey ...	39319	10–10–31	1–9–34	273	26·5	8,734	5·65	493·84	C. H. Ironmonger ...	Rye Duke of Glen Iris (1994)
Lansdowne Morden Lady ...	Guernsey...	3479	10–11–31	10–10–34	273	18	6,219	5·49	341·61	G. E. Scott	Koojen Golden Broadcaster (1632)
Brackenhurst Gibson's Lass II.	A.I.S. ...	7727	29–12–31	23–8–34	273	22	7,153	4·04	289·19	P. E. Warburton ...	Brackenhurst Bouncer (469)
Claremont Pinafore III. ...	do. ...	9936	26–11–31	23–7–34	273	16	6,643	4·07	270·21	Claremont Hospital for Insane	Searchlight of Sunnyvale (2302)
Sabina Vale Fern	Jersey ...	50537	21–11–31	3–9–34	273	13·5	5,020	5·37	269·56	Sabina Vale Stud Farm	Springmead Osram II.
Claremont Fancy V.	A.I.S. ...	9922	16–3–32	12–9–34	210	22·5	6,960	3·76	262·05	Claremont Hospital for Insane	Claremont Herdsman (968)
Muresk Princess	Guernsey...	3879	3–5–32	29–3–35	90	22·5	1,965	4·40	96·24	Muresk Agricultural College	Nundorah Climax

COWS UNDER 2½ YEARS OLD—STANDARD 230 LBS. BUTTER-FAT.

Koojan Ace's Mignonette ...	Guernsey...	3898	23–4–32	1–9–34	273	23·5	6,970	5·90	411·94	A. W. Padbury ...	Homestead Ace (imp. U.S.A.) (1631)
Brookfields Lady Faith ...	do. ...	4062	19–6–32	1–9–34	273	23	5,709	5·24	393·53	G. E. Scott	Koojan Lord Barclay (1031)
Glanavon Dell	A.I.S. ...	8507	2–5–32	23–8–34	273	23	8,694	4·19	364·17	D. Bevan & Sons ...	Villiers of Darbalara (2386)
Glanavon Doris	do. ...	10923	1–8–32	30–8–34	273	23·5	8,998	3·96	356·49	D. Bevan & Sons ...	Villiers of Darbalara (2386)
Sabina Vale Ruby	Jersey ...	...	4–5–32	29–7–34	273	14·5	5,368	5·86	314·63	Sabina Vale Stud Farm	Clarendon Eyre Ruby's Beau
Radyr Park Dorothy II. ...	do. ...	45845	24–7–32	10–8–34	273	14·5	5,057	5·89	298·10	L. Temple	Graceful Lad of Greenmount (7292)
Westly Polly	A.I.S. ...	15141	21–5–32	4–10–34	273	15	7,270	4·07	296·26	Bayley Bros. ...	Telyarup Duke (956)
Drakesbrook Dolly	Guernsey	4141	2–12–32	19–10–34	273	16·5	5,905	4·80	283·51	G. E. Scott	Koojan Land Barclay (1031)
Glanavon Pink Pearl	A.I.S. ...	10927	17–6–32	3–9–34	273	14	7,762	3·46	267·52	D. Bevan & Sons ...	Daphne's Victory of Hillview (1652)
Nooka Bright June	Jersey ...	49855	18–6–32	7–8–34	273	14·5	5,330	4·97	265·17	S. P. Herbert ...	Spring Park Prince Ragtime (4942)
Claremont Flynn 12th	A.I.S. ...	9924	24–8–32	27–8–34	273	11	5,778	4·54	262·29	Claremont Hospital for Insane	Tipperary Daphne's Boy (449)

HERD TESTING—*continued.*

SUPPLEMENT—*continued.*

Name of Cow.	Breed.	Herd Book No.	Date of Birth.	Date of Calving.	No. of Days in Test.	Weight of Milk last day of Test.	Weight of Milk for period.	Average Test.	Weight of Butter-fat for period.	Owner.	Sire.
COWS UNDER 2½ YEARS OLD—STANDARD 230 LBS. BUTTER-FAT—*continued.*						lb.	lb.	%	lb.		
Brookfield's Lady Laurel ...	Guernsey	3904	11-5-32	30-8-34	273	16	5,433	4·74	257·48	G. E. Scott	Koojan Lord Barclay (1031)
Claremont Whitby Maid 15th ...	A.I.S. ...	9950	13-10-32	16-9-34	273	15·5	5,641	4·50	254·10	Claremont Hospital for Insane	Tipperary Virginias Re-Echo (970)
Mokine Empire's Lily 16th ...	Jersey ...	49580	5-9-32	29-9-34	273	14·5	5,113	4·82	246·67	T. H. Wilding ...	Juadine Sunshine
Juadine Peerless Lily 5th ..	do. ...	44519	27-9-32	18-9-34	273	16	5,110	4·67	238·57	Miss L. G. Hancock ...	Juadine Radiance (7598)
Nooka Red Rose	do. ...	49858	28-12-32	3-8-34	273	13·5	4,877	4·82	235·26	S. P. Herbert ...	Pella O.K. (9913)
Claremont Star 7th	A.I.S. ...	9944	23-8-32	6-11-34	180	26	5,715	4·13	228·72	Claremont Hospital for Insane	Claremont Herdsman (968)
Nooka Daisy Queen	Jersey ...	45456	7-11-32	20-7-34	273	13	4,170	5·30	222·09	S. P. Herbert ...	Woodendale Starbright's King III. (10229)
Claremont Blossom 12th ..	A.I.S. ...	9912	14-7-32	25-8-34	273	9·5	5,158	4·29	219·82	Claremont Hospital for Insane	Claremont Elector (446)
Mokine Empire Twylish III. ...	Jersey ...	...	13-9-32	14-9-34	273	11·5	4,024	5·17	207·90	T. H. Wilding ...	Mokine Repulse (5867)
Claremont Blossom XI. ..	A.I.S. ...	9913	13-7-32	26-8-34	240	14	5,010	4·01	207·09	Claremont Hospital for Insane	Claremont Elector (446)
Juadine Sparkle 6th	Jersey ...	44520	14-9-32	14-9-34	273	13	4,204	4·76	200·01	Miss L. G. Hancock ...	Juadine Radiance (7598)
Mokine Sapphire II.	do. ...	49584	20-9-32	26-9-34	273	8	3,699	5·10	188·68	T. H. Wilding ...	Juadine Sunshine
Fairfield Victory's Iris ..	A.I.S. ...	10722	12-10-32	22-8-34	240	12	4,935	3·72	183·45	D. Bevan & Sons ...	Daphne's Victory of Hillview (1652)
Mokine Heroine 7th	Jersey ...	49583	27-9-32	14-9-34	273	9	3,582	4·90	178·84	T. H. Wilding ...	Juadine Sunshine
Claremont Star 9th	A.I.S. .	9945	15-9-32	25-10-34	150	16	3,105	3·98	123·48	Claremont Hospital for Insane	Tipperary Virginia's Re-Echo (970)
Colmyn Dolly	Jersey .	43462	27-4-33	28-2-35	90	12	1,395	4·70	66·21	C. H. Ironmonger ...	Colmyn Captain Mac (5855)

FRUIT FLY—CERATITIS CAPITATA.

BAITING, TRAPPING AND LURING EXPERIMENTS

By L. J. NEWMAN, F.R.E.S., Government Entomologist,
and
C. F. JENKINS, B.A., Assistant Entomologist.

During the past summer and autumn a series of baiting, trapping and luring experiments have been carried out by the Entomological Branch, with a view to testing new and improved baits, traps and lures.

Baiting.—These baiting tests were made in breeding cages, using 50 flies in each, with the poisons arsenate of lead and sodium fluosilicate at varying strengths. The attractants in combination with the poisons were molasses and white sugar.

It was soon demonstrated that the molasses inhibited the poisoning effect of both poisons. This is a chemical reaction which we do not attempt to explain. Dr. Ripley, Department of Agriculture, South Africa, in reporting upon this fact, states in explanation that when treacle is used in combination with sodium fluosilicate, the lime in the treacle reacts chemically with the fluosilicate, producing compounds of much lower toxicity, but that it is not yet understood why it also lowers the toxicity of arsenate of lead. The same appears to apply to the use of molasses, as has definitely been proved in our experiments. Replacing the molasses by sugar, the toxic powers of these two poisons do not appear to be affected.

The use of molasses in the local arsenate of lead foliage bait accounts for the comparatively slow poisoning action on the fruit fly. This bait takes from 8 to 10 days to give 100% kill. It is probable that many of the flies continue to lay a proportion of their eggs after taking the bait. This bait, however, when applied systematically and regularly once a week, has considerably helped in the control of fruit fly. In the experiments just completed it has been definitely proved that sodium fluosilicate, when used with sugar, is more highly toxic to the fruit fly than arsenate of lead and sugar. The flies readily partake of the bait containing this poison and quickly die.

The following formula was used with great success:—

Test 1.

Sodium fluosilicate—1 oz.
White Sugar—2½ lbs.
Water—4 gallons.

This resulted in 100 per cent. kill of flies in 46 hours.

Test 2.—Formula:

Sodium fluosilicate—1 oz.
Molasses—4 lbs.
Water—4 gallons.

It will be noted that the only difference was the substitution of the molasses for the sugar. This took 168 hours, or seven days, to give 100 per cent. kill of flies, against 46 hours when white usgar was used.

Following this definite proof of the inhibiting effect of molasses on the toxicity of sodium fluosilicate, similar tests where conducted with arsenate of lead.

Test 3.—Formula:

Powdered Arsenate of Lead—5 ozs.
White Sugar—4 lbs.
Water—4 gallons.

This gave a 100 per cent. kill in 120 hours or 5¼ days.

Test 4.

The same formula, substituting molasses for the white sugar.

Powdered Arsenate of Lead—5 ozs.
Molasses—4 lbs.
Water—4 gallons.

Result—100 per cent. kill of flies in 216 hours, or nine days—nearly twice as long as when white sugar was used.

This demonstrated that molasses has the same effect of reducing the toxicity of arsenate of lead as it had on the sodium fluosilicate.

Test 5.—Formula:

Powdered Arsenate of Lead—3 ozs.
White Sugar—4 lbs.
Water—4 gallons.

This resulted in 100 per cent. death of flies in 144 hours or six days. This was only 16 hours more than when 5 ozs. of the arsenate of lead was used with sugar.

This would seem to indicate that there is not sufficient advantage gained by the increase of the arsenate of lead content above the 3 ozs. to the four gallons of water.

A further test was made with the sodium fluosilicate and molasses, doubling the amount of the poison.

Formula:

Sodium fluosilicate—2 ozs.
Molasses—4 lbs.
Water—4 gallons.

This resulted in 100 per cent. kill of flies in 168 hours or seven days, being five days longer than when 1 oz. of the sodium fluosilicate was used with 2½ lbs. of white sugar to 4 gallons of water.

In carrying out these baiting experiments, all tests were duplicated.

To determine whether sodium fluosilicate would in any way injure trees or plants, a series of spraying trials were undertaken using double strength. This spray was applied to all kinds of fruit trees, shrubs and flowers, with negative effect, no sign of burning being noticeable. The bait was also found to remain moist and sticky for several days.

As the result of these series of experiments, the following foliage bait is advised:—

Formula:

Sodium fluosilicate—1 oz.
Sugar—2½ lbs.
Water—4 gallons.

The cost of this bait should not exceed 4d. per gallon. Allowing that each tree carrying fruit will require ½ pint of the bait, 1 gallon should be sufficient for 16 trees. The bait must be applied at least once every seven days and renewed when washed off by heavy rain.

Foliage baiting of deciduous fruit trees should be commenced when fruit is within seven weeks of ripening and continued until fruit is picked. Baiting of citrus trees carrying fruit should commence by the 1st of September and continue to the end of May. Advantage should also be taken of any fine period during the winter to apply the bait, thus poisoning the over-wintering flies.

It is important to refrain from baiting any fruit trees during the period of blossoming, as by so doing there is great danger of poisoning bees and other useful wasps, etc., which frequent the flowers. The fruit fly is essentially a fruit infesting insect and does not attack the flowers.

The alternative formula, if sodium fluosilicate is for any reason not procurable, is the following:—

Powder arsenate of lead—3 ozs.
White sugar—2½ lbs.
Water—4 gallons.

The juice of any fruit in season may be added.

In applying this bait it is essential to keep it well agitated as the poison has a tendency to precipitate to the bottom of the spray pump or bucket. The spray should not be applied too finely, a coarse nozzle being used so that it falls on to the leaves in the form of small rain drops. Apply to certain patches of foliage on two to four sides of the tree, avoiding the fruit.

Trapping.—Four types of covered traps were used namely Brown's, "Slip On," new type, "Slip On," old type, and Green's new type. The "Slip On" old type was used as the control. The period of the test was from 8th April to the end of May.

The results were as follows:—

Brown's captured 2,640 fruit flies.
"Slip On" new type—2,559 fruit flies.
"Slip On" old type—2,110 fruit flies.
Green's new type—1,959 fruit flies.

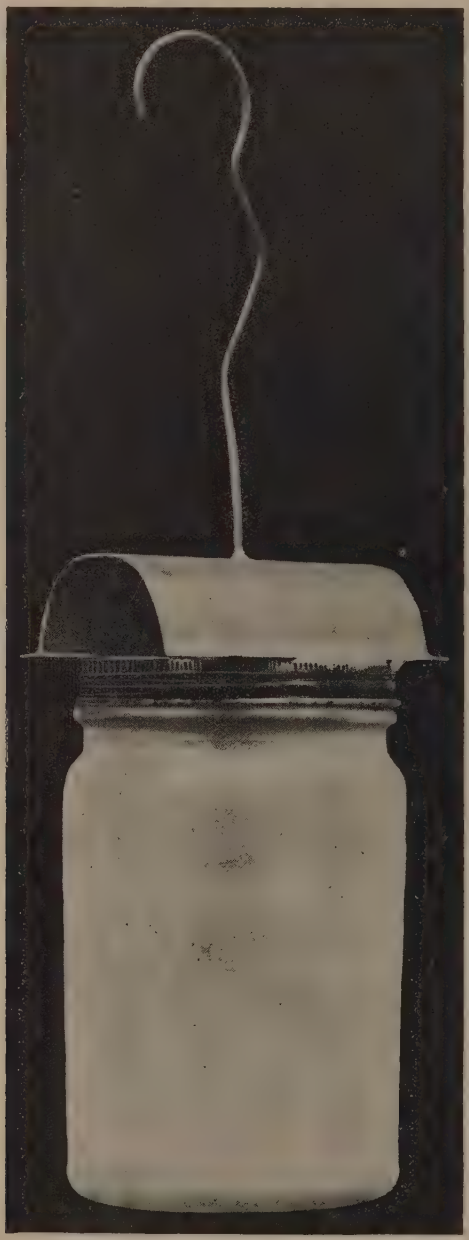
From these figures it will be seen that there is not much to choose between the first three traps, Brown's trap, which is not a proprietary trap, capturing the highest number.

Brown's trap, herein illustrated, is simple to construct. It is made with little labour, from any metal screw-topped glass jar, of about half a pint capacity. A hole about one inch in diameter is stamped or cut out in the centre of the lid. Over this hole is soldered a piece of galvanised iron in the shape of a small hood. To the hood is attached a piece of pliable wire, whereby the trap is suspended in the tree.

It is necessary that all traps shall be covered, as this reduces the evaporation of the lure, prevents flooding by rain and spilling over during windy weather. Covered traps can be used in citrus trees through the winter months, thus capturing the over-wintering flies.

In small orchards up to 200 trees, trapping is advised. At least two traps per tree should be used, the more the better. The traps should be placed about half way up the trees. During the months of November to March inclusive, they should be hung in a shady position and from April to October in sunny aspect.

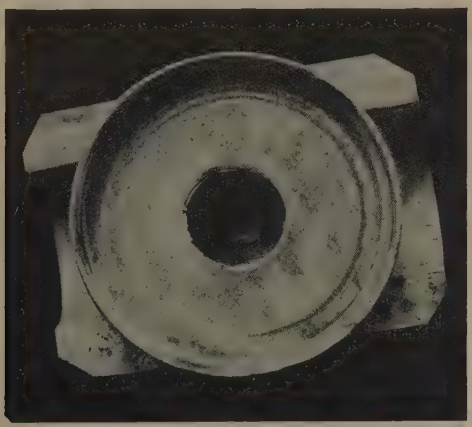
In orchards of over two acres, it is recognised that the trapping method cannot be economically applied, foliage baiting being cheaper and more efficient. Traps can be used in large orchards as indicators, as to whether the fruit flies are present, thus acting as a guide for spraying.



Brown's Fruit Fly Trap.

Note.—In this case the bottle was whitened for photographic purposes. A clear glass screw-topped bottle should be used.

Lures.—Beeco, clensel and Bordeaux mixture were the lures tested. Clensel was found to be the most effective and is therefore preferred. Beeco was also good. Bordeaux mixture proved somewhat attractive, but could not be called satisfactory. Clensel, 1 part to 30 parts water, is the luring formula recommended. It is easy to mix, the traps remain clean, and the captured flies are easily visible.



View of under-side of lid showing hole cut for admittance of fly.

Finally, it must be pointed out that foliage baiting and luring must be supplemented by complete orchard sanitation, which means that all infested fruits must be picked from trees or ground daily and destroyed.

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THE MEASUREMENT OF THE pH VALUES OF BUTTER SERUM.

H. KRETCHMAR, B.Sc., A.A.C.I., F.C.S.

Recent work carried out in Ireland (i) and Victoria (ii) has shown the importance of the pH value of the serum of butter, as one of the major factors affecting the keeping quality of butter during storage.

The Superintendent of Dairying (Mr. G. K. Baron-Hay) having indicated the desirability of an investigation into the pH values of the sera of local butters, considerable attention has been given by the writer to this problem during recent months. The work herein described has been carried out to find a simple, easy, rapid and generally satisfactory method for the routine determination of this physico-chemical constant.

The colorimetric method does not appear to be adaptable to this work for several reasons. An accuracy greater than about 0.2 of a pH unit is not thereby attainable. The quantity of serum required for the test as carried out with the

usual apparatus is large, necessitating the taking of large samples of butter and precluding the use of the simple method of separating the serum from the butter-fat to be later described. The writer has not had experience with the micro-colorimetric method, but the cleaning of the capillary tubes alone would appear to be an objection when dealing with such material as butter serum. Hence it would seem that the electrometric method is better.

Having chosen the electrometric method it remains to choose the electrode system. The writer does not believe in referring measurements to any reference system more remote from the standard system than is necessary, because, apart from any weaknesses in the method chosen, there is always the risk of errors occurring in the measurements which have to be made when referring back to the accepted standards. Standards are chosen as such because of definite inherent qualities such as stability and accurate reproducibility. On these grounds, such half cells as platinum wires dipping into buffer solutions saturated with quinhydrone have been dismissed.

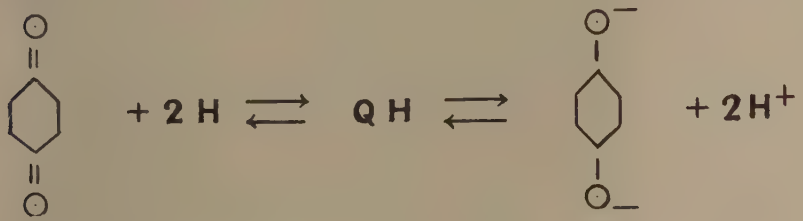
For the half cell containing the liquid to be tested, the more usual systems employ the hydrogen electrode or the quinhydrone electrode. For this particular problem the hydrogen electrode does not appear to be suitable, for apart from its slowness in assuming equilibrium, there are the disadvantages of, (a) possible "poisoning" of the platinum contact, (b) the time consumed in cleaning the platinum, (c) the possible danger of the hydrogen in the presence of the platinum "hydrogenating" some of the biological materials and altering the pH values, (d) the additional apparatus, gas generator (or gas holder and valve), gas cleaners, etc., and trouble attendant on its use.

The quinhydrone electrode is more promising. A very simple electrode vessel is easily arranged. It can be designed so that the quantity of material required for a test is small; in the apparatus illustrated about 1 cc. is used. The potential of the electrode compared with the standard hydrogen electrode is accurately known. It rapidly assumes equilibrium with the solution being tested, and the quantity of reagent, quinhydrone, required for a test is very small. Its main disadvantages are (a) it is not accurate in solutions having a higher pH value than 8.0 unless the solution is highly buffered when the range may be extended to about pH 9.0, (b) there is the possibility of side reactions taking place between the quinhydrone and the material being tested which will alter the molecular ratio of quinone to hydroquinone, thus upsetting the electrode potential, (c) it has appreciable "protein errors," (d) it has appreciable "salt errors." The limitation given under (a) is of no consequence here as the previous work (1) and (2) has shown that the pH values to be measured will almost certainly not reach the value 8.0. The objection given under (b) is probably only valid for solutions containing strong oxidising or reducing agents. Kolthoff found the "protein error" to be of the order of 0.1 — 0.2 of a pH unit with blood serum and with casein NaOH solutions. Thus the "protein error" may be quite appreciable with butter serum. Sorensen has shown the "salt error" amounts to 0.01 of a pH unit when the salt concentration is 0.2 molar., and 0.2 of a pH unit when the salt is 4 molar. in concentration. If we assume the average moisture content of butter to be 15.5 per cent. and the average salt content to be 2 per cent. the concentration of salt in the serum will be about 2 molar. Thus the "salt error" may be quite appreciable with butter serum. The magnitude of the "errors" mentioned above is to be determined by future work but, in the meantime, the ordinary quinhydrone combination may be used to obtain comparative values. It is worth remembering that the potential of the quinhydrone-hydroquinone half cell is said to be independent of salt concentration but it will be better if the quinhydrone combination can be employed.

For the second standard half-cell one of the calomel type would seem to be most suitable. Calomel half-cells are easily made up, especially the saturated form for which no standardised solutions need to be prepared. If the mercury calomel mixture be an electrolytic preparation from the best HCl (A.R.) and carefully purified mercury, and if the best KCl (A.R.) be used the E.M.F. accepted as standard is readily reproduced.

Calculation of the pH Value from the Measured E.M.F.

Quinhydrone is an equimolecular compound of quinone and hydroquinone into which compounds it is partially dissociated in water. Further, an equilibrium is set up between the constituent compounds and the hydrogen ions of the solution thus:—



A saturated solution at 25° C. takes up 3.94 gms. quinhydrone per 100 ccs. of water.

The measured E.M.F. of the system is:—

$$E = E \text{ quin.} - E \text{ cal.} + \frac{RT}{F} \log_e [H+]$$

$$= E \text{ quin.} - E \text{ cal.} + 2.303 \frac{RT}{F} \log_{10} [H+]$$

Where E quin. is the potential of the normal quinhydrone electrode compared with the normal hydrogen electrode taken as 0.

E. cal. is the potential of the saturated calomel electrode compared with the normal hydrogen electrode taken as 0.

R is the gas constant.

T is the absolute temperature of the experiment.

F is Faraday's constant.

The following are the standard electrode potentials at various temperatures together with the value of the difference of their potentials:—

Temp. °C.	E sat. cal.	E quin.	E diff.
18°	.2511	.7044	.4533
20°	.2496	.7029	.4533
25°	.2458	.6992	.4534
30°	.2420	.6955	.4535
35°	.2382	.6918	.4536

Thus, over the range 18° C. to 25° C. the E.M.F. due to the two standard half-cells is constant at .4535 volt measured to the nearest 0.5 M.V., the calomel electrode being negative with respect to the quinhydrone electrode.

The following are the calculated values of the term

$$2.303 \frac{RT}{F}$$

at various temperatures:—

Temp. °C.	$2.303 \frac{RT}{F}$
18°	.0577
20°	.0581
25°	.0591
30°	.0601

Thus, using accepted values for the standard electrode potentials at any temperature, it will be possible to construct a graph drawing an E.M.F.—pH line for any desired temperature relating a measured E.M.F. to the pH of the serum.

During the winter months it will be possible to work the constant temperature chamber at 18° C. (64° F.) but during the summer it will be necessary to work at 25° C. (77° F) or 30° C. (86° F.).

To enable a graph to be drawn three points have been calculated for each line of the graph at these three temperatures, (one point being useful as a check on the others). These are shown in the following table:—

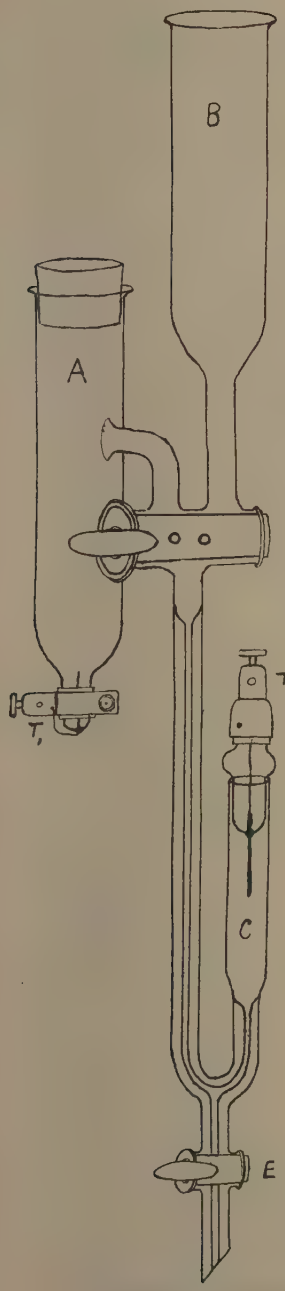
Temp. °C.	pH of Soln.	E.M.F. (Volts).
18°	7.0	.0495
	5.5	.1360
	2.0	.3380
25°	7.0	.0410
	5.5	.1295
	2.0	.3360
30°	7.0	.0330
	5.5	.1230
	2.0	.3335

EXPERIMENTAL METHODS.

1. *Separation of the Serum.*

The usual method (iii.) of separating the serum from the butter-fat is to heat a portion of the butter in a glass vessel; allow the butter to separate into two phases; separate off the aqueous phase and filter. This method of obtaining the serum appears to be clumsy and protracted as well as being wasteful of material. The writer prefers to centrifuge a small quantity of butter in an electrically-heated centrifuge kept at 45°—50° C., which rapidly separates the serum from the butter-fat and also separates most of the curd from the serum.

No electrically-heated centrifuge being available an ordinary blood centrifuge was adapted for the work. The original thin "tin" dish-shaped cover was removed and a strong welded steel straight-sided shield made to take its place. This shield is made of sheet steel approximately $\frac{1}{8}$in. thick (10 gauge), is 6$\frac{1}{2}$in. deep and 13in. diameter externally. The original lid is used, the only modification being the addition of a short piece of brass tube 1$\frac{1}{2}$in. long and $\frac{1}{2}$in. diameter, placed centrally to take a thermometer. The base projects slightly beyond the sides, making a platform on which the lagging, etc., rests. The vertical side of the shield is covered with mica sheet over which is placed the heating winding consisting of 25 B. & S. gauge (26 S.W.G.) nichrome wire coiled to keep it of reasonable length. Between the turns of coiled wire is wound asbestos string to prevent flattening of the turns by the outer lagging. Over the whole is placed the lagging



ELECTRODE APPARATUS.

of ¼in. thick sheet asbestos which is securely held in place by a thin galvanised iron outer cover. The resistance of the winding is chosen to keep the current (at 250 volts) down to such a figure as will heat the centrifuge to 60° C. maximum working temperature. It takes 0.8 amps. and the power consumed is thus 200 watts. The time taken for the centrifuge to heat from 15° C. to 50° C. is 25 minutes.

The original thin glass conical blood tubes have been discarded as too fragile and others of the following approximate dimensions substituted:—⅝in. diameter externally, 4½in. deep externally, 3/64in. thick walls, of capacity 15 ccs. with hemispherical bottom. These were constructed from glass tubing.

Design of Electrode Vessel.

As will be seen from the diagram the electrode vessel comprises three parts connected by a three-way stopcock D. The vessel A has a platinum connection sealed into the base, the platinum being soldered to the terminal T_1. Terminals can easily be fitted to vessels as shown, by soldering them first to a piece of very thin brass (shim metal) which is bent around the vessel with a piece of rubber tubing between the brass and the glass, the ends of the metal being drawn together by a small B.A. bolt and nut. In the bottom of A is placed the purified mercury and on top of this a layer of electrolytic calomel plus mercury mixture together with a little A.R. potassium chloride. The vessel is filled with saturated A.R. potassium chloride solution. The vessel B is also filled with the saturated solution of A.R. potassium chloride. The vessel C, which is connected to the stopcock D by capillary glass tubing, serves to hold the liquid being tested. Although vessels are shown in the literature without the tube of junction liquid entering the liquid to be tested as in this apparatus, *i.e.*, from beneath, the writer finds this is an essential point, for, if dipped in from above the saturated potassium chloride solution rapidly diffuses into the liquid being tested. A second platinum electrode is sealed into a piece of glass tube F and connected to the terminal T_2. A ridge on F makes it rest neatly just in the vessel C. The stopcock D serves to connect the standard calomel electrode A to the vessel C containing the serum being tested saturated with quinhydrone and mixed with a slight excess of quinhydrone, or to connect the vessel B with the vessel C. The stopcock E serves for emptying the

vessel C after each determination. After C has been emptied and thoroughly washed with distilled water a little saturated potassium chloride solution is run through from B to make sure any contaminated potassium chloride solution is removed. E is then closed, saturated potassium chloride solution run through until it just fills the connecting tube to the bottom of the vessel C, the next lot of serum to be tested plus quinhydrone is run into C and the carefully cleaned electrode F replaced. The stopcock D is then turned to connect the vessels A and C and everything is ready for the determination of the E.M.F., which becomes steady after a few minutes lapse of time.

For the measurement of the E.M.F. the potentiometer made by the Cambridge Instrument Co., Ltd., England, is very suitable. No standard cell is required for standardising the instrument. One has only to turn a switch to the position marked standardise potentiometer, turn the potential indicator dial and potential indicator switch to zero, and then adjust the resistance included in the set until the standard marked deflection of the galvanometer is obtained on depressing the tapping key. The instrument is then standardised and after turning the first mentioned switch back to the position marked test may be used for making measurements.

At the beginning of a day's work, the system should be checked against a standard buffer solution. The writer prefers Clark & Lubs' phthalate hydrochloric acid buffers or phthalate sodium hydroxide buffers as being the most easily reproduced with accuracy.

It is thought that the method described above offers the following advantages over those previously described:—

1. Rapidity with which determinations may be made.
2. Ease of operation and cleaning.
3. Accuracy. Direct comparison with accepted standards.
4. Availability at any temperature.
5. Simplicity of construction of apparatus.
6. Requirement of only small amount of material to be tested and reagents.

Acknowledgment.

The writer desires to acknowledge gratefully the assistance received from Dr. G. A. Elliott, Lecturer in Chemistry at the University of Western Australia, who kindly consented to peruse critically the manuscript and who made many helpful suggestions.

References.

(i) "Journal of Agriculture," Irish Free State, XXXII., No. 2, p. 264, *et seq.*

(ii) "Journal of Dairy Research," V., No. 2, p. 124, *et seq.*

(iii) Industrial and Engineering Chemistry. (Anal. Ed.) III., p. 374.

PREPARATION OF WOOL FOR MARKET.

NECESSITY FOR CORRECT CLASSING.

HUGH MCCALLUM,
Sheep and Wool Inspector, Department of Agriculture.

During the past season more regularity was shown in the classing of clips than in the previous season, but there is still room for improvement. The standard must be kept high because it will enable the buyers closely to estimate the clean-scoured yield of each separate lot, and because the carefully classed wools command the widest and keenest competition. The growers must pay the strictest attention to every detail in the "get up" of their clips, whether it be large or small. Wool classed for quality, length and condition appeals to every buyer, and is not passed by on account of containing mixed qualities in one or more bales. It is obviously in the grower's interests that these qualities should not appear in the same bale.

Selling brokers should have the correct particulars of the quality contained in each bale to assist them in preparing the catalogue. Each lot on the show floor is represented by a percentage of show bales. Brokers' experts inspect the show bales to see that the quality is even, and prior to the sale each lot is valued. Many clips forwarded to the brokers are reclassed, otherwise they would receive unsatisfactory returns.

The shearing should be conducted under the best possible conditions. Plenty of room is necessary to have sufficient cover for sheep, and the wool room should be well lighted, with plenty of space provided for wool tables, bins, wool press and baskets. For skirting and rolling, a good wool table is necessary and it should be about nine to ten feet long, four to five feet wide and three feet high. After each sheep is shorn, the fleece is picked up by each hind-quarter or leg in the hands. Do not loosen the grip, but gather your closed hands around all the fleece right at the feet and carry it to the rolling table. By retaining the hold and throwing your arms out from you over the table, the fleece spreads evenly, neck and fore-quarters going to the farther end and the breech and thigh portions of the fleece remaining at the end of the table from which you are throwing. As the fleeces are spread on the table they should be carefully shaken to remove second cuts and fribs, and every care should be exercised to see that the skirting is uniformly done. The skirtings should not be thrown on the floor, but in baskets, and then passed to the piece picking table. When rolling the fleece, turn in the neck end first, then the breech end and one side; a third of the width of the fleece is folded in. The folded portion is next turned right over to the further edge of the fleece, so that the fleece is now folded in three laps, the back showing on top, and it is then rolled from tail to neck. The back, which is the least attractive wool, is now rolled in the centre which is an advantage on the old style of rolling.

On no account should fleeces be placed straight into a bale, but placed in bins erected in the shed. When there is sufficient wool in a bin to make a bale, it should be pressed. A few sample fleeces should be left in each bin for comparison.

Wool classing consists of matching and the number of classes is determined by the size of the flock. Before pressing the wool look carefully over each bin, and if any fleece appears out of place with the balance remove it to another bin. If in doubt put same in the next lower class.

Agricultural and Southern wools should be classed as under:—

Merino. Degrees of quality are fine (70's); medium (64's), and strong (60's).

Super. 70's and upwards only to be made from which warrant the quality and quantity.

AAA Com. Sound, good length, light condition, 64's and upwards.

AA Com. Sound, shorter in staple, heavier condition, 64's and upwards.

A Com. Short and very heavy, also black tipped fleeces.

AAA FLC. Tender, good length, light to medium condition, 64's upwards. Any short tenders can go into A Com. Any strong tenders to go into BB.

BBB. Sound, good length, light to medium condition, 60's.

BB. Shorter, heavy condition, 60's (anything rough and daggy must be placed in bags or fadges).

AAA PCS. Longest, brightest and light condition, 64's/60's.

AA PCS. Shorter and heavier, 64's/60's. (Breech ends and starey necks must be put in bags or fadges.)

AAA BLS. One line, minus stains. Two lines may be made if clips warrant it. These will be bulky (1) the shortest; (2) minus stains.

STD PCS. One line only, minus dags.

LKS. One line only, minus dags.

AAA LBS. Longest and light to medium condition, 64's/60's.

AA LBS. Short and heavy, 64's/60's. Any rough lambs to be placed in bags.

COMEBACKS AND CROSSBREDS.

Owing to a substantial increase in this class of wool caused by mixed farmers breeding export lambs, many small clips are forwarded for sale that are not classed satisfactorily. It behoves owners, large and small, to be careful in the preparation of these classes, as it is found impossible in many instances, owing to the mixed quality of the wool, to correctly estimate and to give full value. Classes should be made of each type to enable the grower to obtain the highest price.

Wool from crossbred lambs is difficult to class on account of the variations in quality, but it is to the owner's interest to keep the coarser wool separate from the finer qualities.

Comeback and Crossbred:

AAA CBK. Good length, light to medium condition 58/60's.

AA CBK. Shorter, heavier 58/60's.

AAA XB. Good length, light to medium condition 56's.

AA XB. Good length, light to medium condition 48/50's.

XB. Good length, light to medium condition 40/46's.

XB COMB. Cast line, cotty discoloured and rough fleeces.

CBK PCS. 58's average minus sweats.

XB PCS. Mixed qualities minus sweats.

CBK BLS. 58's average minus sweats.

XB BLS. Mixed qualities.

XB & CBK STD PCS. One line.

CBK BLS. 58/60's medium to light condition.

XB LBS. 56's medium to light condition.

LBS. Mixed qualities.

In many of the wheat belt districts the back portion of the fleece collects dust; it is a mistake to leave them in the fleece, as they make the wool look shabby. Do not mix the pieces and bellies together; this is most undesirable.

PRESSING AND BRANDING THE BALE.

This is a most important feature in the preparation of the wool clip; a well pressed and an evenly formed bale finds favour with the buyers. With a little care the classer can prevent mixed bales, that is, putting more than one quality into a bale. Three and four different qualities have often been seen in one bale, which is not conducive to the best results.

A good plain brand is required on the bale. The initials of the owner over the name of the property is all that is necessary. The worst type of brand is generally found where the owner has placed his stock brand on the bales; this leads to confusion. The continuous development of our lands and the increase of small clips yearly, makes plain branding of wool all the more essential. Use stencil plates, and choose a brand which is distinctive and bold. Small letters should not be used on any account. Name and numbers should be four inches in length and fairly blocky. Do not brand anything on the ends of the bale.

The Agricultural Department will be pleased to answer any questions or give advice to any grower who may require more information on any of the points mentioned in connection with the preparation of the Farmers' Clip.

MAIZE VARIETY TRIALS, 1935-36.

H. G. Elliott,

Agricultural Adviser, Dairy Branch, Department of Agriculture.

The maize variety trials were conducted again this season. From the results obtained during the previous two seasons the indications were that "Fitzroy" was slightly superior to "Hickory King" for a green fodder crop, but "Hickory King" was still recommended as the standard variety for this State.

The object of the trials was to determine which variety, if any, of the ones listed below would give higher yields of green material per acre than "Hickory King." The varieties used were:—

1. "Hickory King"—standard for green fodder in this State.
2. "Fitzroy."
3. "Silvermine."
4. "Small Leaming."
5. "Wellingrove."
6. "Mammoth White Ensilage."
7. "Golden Superb."

The last two named were used for the first time this season, and the following four varieties were deleted from the trials owing to unsuitability:—

1. "Early White Dawn."
2. "Funk's Early Yellow Dent."
3. "Early Morn."
4. "90-Day Flint."

Fertiliser.—Superphosphate and ammonia No. 3, which in proportions of 2½ parts superphosphate and 1 part of sulphate of ammonia, at the rate of 3 cwts. per acre was used. This fertiliser mixture and the rate per acre were the same as in previous trials. The cost of fertilisers was again borne equally by Cuming Smith & Mt. Lyell Farmers' Fertilisers, Ltd., and the Department of Agriculture.

Each variety was sown in triplicate in rows of 30 inches apart, 25 lbs. of seed per acre being sown in every case.

TABLE 1.

GREEN MATERIAL PER ACRE.

				Hickory King.	Fitzroy.	Silvermine.	Small Leaning.	Wellingrove.	Mammoth White Ensilage.	Golden Superb.
J. H. Oldfield ...	Forest Grove ...	Tons per acre ...	...	8·95	8·4	8·83	8·53	8·06	...	9·58
		Percentage Yield ...	...	100	94	98	95	100	...	107
V. E. Dawson ...	Vasse ...	Tons per acre ...	...	7·38	7·81	8·29	8·29	7·38	8·68	9·12
		Percentage yield ...	...	100	106	112	112	100	118	123
O. Green	Harvey ...	Tons per acre ...	...	17·05	18·21	12·66	21·91	14·46	12·76	...
		Percentage yield ...	...	100	107	74	128	83	75	...
S. F. Russell ...	Serpentine ...	Tons per acre ...	...	21·5	...	19·2	22·5	22·0	22·25	15·39
		Percentage Yield ...	...	100	...	90	105	102	103	71
J. T. N. Downes ...	Northcliffe ...	Tons per acre ...	...	15·6	15·1	21·0	15·4	15·9	15·1	13·5
		Percentage yield ...	...	100	96	134	98	102	96	86
J. W. Pratt ...	Northcliffe ...	Tons per acre ...	...	21·5	23·8	30·8	20·7	20·3	24·06	21·5
		Percentage yield ...	...	100	134	143	97	94	111	100
T. B. Stanley ...	Brunswick ...	Tons per acre ...	...	22·62	22·15	18·75	19·76	17·68	26·06	20·05
		Percentage yield ...	...	100	98	83	87	78	115	93
H. A. Barber ...	Manjimup ...	Tons per acre ...	...	23·3	28·8	20·2	21·1	22·2	...	23·0
		Percentage yield ...	...	100	123	86	90	95	...	98
L. R. Barnsby ...	Pemberton ...	Tons per acre ...	...	11·01	14·25	13·39	14·37	15·5	...	13·9
		Percentage yield ...	...	100	129	121	130	140	...	126
Average	... ...	Tons per acre ...	...	16·55	17·94	17·01	16·95	16·04	18·15	15·865
		Percentage yield ...	...	100	108	103	102	97	110	96

The average production of green material and percentage yields for all trials for the three seasons 1933-34 to 1935-36 are given in the following table:—

TABLE 2.

GREEN MATERIAL.

Variety.	1935–36.			1934–35.			1933–34.			Average—1933–36.		
	Average Yield per Acre.	Percentage Yield.	No. of Trials.	Average Yield per Acre.	Percentage Yield.	No. of Trials.	Average Yield per Acre.	Percentage Yield.	No. of Trials.	Yield per Acre.	Percentage Yield.	No. of Trials.
	tons.			tons.			tons.			tons.		
Hickory King	16·55	100	9	18·19	100	12	17·23	100	25	17·35	100	46
Fitzroy	17·94	108	8	21·80	120	6	19·87	115	13	19·73	113	27
Silvermine	17·01	103	9	19·83	109	6	17·32	100	12	17·77	102	27
Small Leaming	16·95	102	9	17·33	95	6	17·08	99	13	17·09	98	28
Wellingrove	16·04	97	9	18·16	100	6	16·16	94	13	16·54	95	28
Mammoth White Ensilage ...	18·15	110	6	...	...	...	...	...	...	18·15	105	6
Golden Superb	15·87	96	8	...	...	...	...	...	...	15·87	91	8
Funk's Early Yellow Dent ...	...	...	...	15·30	84	6	17·74	91	12	16·93	97	18
90 Day (Flint)	...	...	...	16·33	90	6	14·45	84	11	15·11	86	17
Early Morn	...	...	...	13·79	76	6	13·60	78	12	13·60	78	18
Early White Dawn	...	...	...	14·56	80	6	13·40	78	11	13·81	79	17

USEFUL BIRDS OF WESTERN AUSTRALIA.

SERIES III.

THE STRAW-NECKED IBIS.

(*Threskiornis spinicollis.*)

C. F. H. JENKINS, B.A.
Assistant Entomologist, Department of Agriculture.

The Ibis family (*Plegadidae*) has three representatives in Australia, namely, the almost cosmopolitan Glossy Ibis (*Plegadis falcinellus*), the Australian White Ibis (*Threskiornis molucca*) and the Straw-necked Ibis (*Threskiornis spinicollis*).

The Glossy Ibis is the smallest of the three, measuring about 21 inches in length and is easily recognised by its dark burnished plumage. The White Ibis can also be easily distinguished for, with the exception of the black head and neck, and a few plumes of the same colour on the back, the popular name gives a true description of its appearance.

The Straw-necked Ibis is the species which is best known in Western Australia, for the Glossy variety is only rarely met with, and the White Ibis does not come lower than South-West Cape on this side of the continent, although in the Eastern States the three forms may be met with in the same locality. The general colouring of the upper surface of the body, including the wings, is greenish black and the under parts are pure white. The neck and breast of the bird are adorned with a "bib" of straw-like feathers, rather better developed in the male than in the female, but serving as an unmistakable identification mark in both. This species is slightly smaller than the White Ibis, measuring about 24 inches in length, eight or nine inches of which are accounted for by the sickle-shaped bill.

The Straw-necked Ibis is nomadic in its habits, regulating its movements according to the seasons. It is typically a swamp loving bird, but in wet seasons will be distributed over wide stretches of country. During the present winter the birds have been particularly plentiful in many parts of the South-West, their numbers having been probably augmented by visitors from the drought stricken areas. In flight the Ibis is easily recognised by its conspicuous black and white colouration and the long curved beak. Parties of these birds frequently fly in formation when undertaking long flights, forming themselves into a V, and following with great regularity the evolutions of the leader.

There are few more useful birds than this Ibis for it feeds largely upon insects, and grasshoppers figure prominently in its diet. A striking illustration of the enormous quantity of noxious insects destroyed by these birds was given by the late Dudley Le Souef. He visited an Ibis rookery in one of the swamps in the Riverina and recounts the incident as follows:—"The birds occupied about 300 acres, and as the swamp was approached a curious sound, something like surf breaking on the shore, was heard, caused by the immense number of Straw-necked Ibis flying about and emitting their hoarse cries." The minimum number of birds occupying the rookery was estimated at 200,000 and the contents of an average crop of an adult bird by actual counting was 2,410 young grasshoppers, five fresh-water snails, several caterpillars and some coarse gravel, which, multiplied by 200,000, makes up a total of 482,000,000 grasshoppers, as well as a vast number of caterpillars and snails. The latter are the intermediate host of the liver fluke

which infests sheep in the Eastern States, and so are of considerable economic importance. The weight of the contents of the crop of an adult bird averaged 4½ ounces, so that the total weights of their stomachs reached about 25 tons.

From these extraordinary figures it will be seen that the Ibis is an invaluable bird and a great ally against the grasshopper. In certain districts it plays an important part in the control of this pest as the following note by a Victorian grazier will testify:—"In autumn, 1907, when we had no grass we irrigated a few

Straw-necked Ibis.

acres for the stud rams, but as soon as the grass came up we had the grasshoppers. They arrived one day at 7 a.m. and the Ibis at 12 o'clock. By their timely arrival and action they saved the garden."

Although immense rookeries like those situated in the Riverina have not been located in our own State, quite large companies have been found breeding in the vicinity of the Gascoyne River, as well as some of the swamps further south. The

nests are usually placed in reeds or low bushes just above the water level, the bushes being broken down to form a foundation for further sticks and reeds. Three to four decidedly coarse-textured eggs comprise the usual clutch. They are dull white in colour and measure a little over 2½ inches by 1¾ inches.

Ibises of all kinds are totally protected throughout the State, but this does not prevent many of them from falling victims to duck shooters when legitimate game is scarce. There is little opportunity of enforcing the game laws in many parts, and it is only when legislation is backed by popular opinion that it is likely to be effective in this direction, but, if the insect-destroying propensities of the Ibis are borne in mind, it should not be difficult to arouse a very real sentiment in favour of this valuable bird.

MAIZE FERTILISER TRIALS, 1935-36.

H. G. ELLIOTT, Agricultural Adviser, Dairy Branch.

These trials were continued at centres throughout the South-West during the past season, 1935-36.

As was the case the previous seasons, Messrs. Cuming Smith & Mt. Lyell Farmers' Fertilisers, Ltd., again generously agreed to donate half the fertiliser required for the experiments.

The fertiliser mixtures are shown below with the abbreviated nomenclature adopted in referring to these fertilisers in the results:—

S3—Superphosphate 3 cwts. per acre—Control.

S3, A1—Superphosphate 3 cwts. per acre plus sulphate of ammonia 1 cwt. per acre.

S3, A2—Superphosphate 3 cwts. per acre plus sulphate of ammonia 2 cwts. per acre.

S3, A3—Superphosphate 3 cwts. per acre plus sulphate of ammonia 3 cwts. per acre.

S3, A3, K½—Superphosphate—
3 cwts. per acre plus sulphate of ammonia.
3 cwts. per acre plus sulphate of potash.
½ cwt. per acre.

The object of the experiments was to compare yields from the above fertiliser treatments in order to ascertain the most economical and suitable applications.

Each plot was of one-twentieth acre and each treatment was replicated three times.

Non-Irrigated Trials.

1. Messrs. Bee Bros., Keysbrook.

Soil.—Grey to brown sandy loam overlying clay. The land had been under clover pasture prior to planting and originally carried marri and jarrah.

Cultivation.—Soil prepared by spring ploughing and harrowing, being re-ploughed prior to planting.

Method of Sowing.—Fertiliser was applied every third furrow and lightly covered with soil, and the seed was sown to a depth of 2-2½ inches in the same rows.

Rate of Seeding.—36 lbs. per acre.

Variety.—"Hickory King."

Distance between rows—30 inches.

Weights taken on 5th February, 1936.

Germination.—Very irregular in the high ammonia treatments on plots 5, 12, and 19, also on plots of high ammonia and potash, Nos. 6, 13, and 20.

TABLE 1.—RESULTS OF TRIALS: BEE BROS., KEYSBROOK.

Fertiliser.	Cost of Fertiliser per acre plus freight.*	Average Yield per acre.	Percentage Yield.	Value of Yield per scre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 13 2	8·45	100	6 6 9	5 13 7
S3, A1 ...	1 5 3	9·80	116	7 7 0	6 1 9
S3, A2 ...	1 17 5	9·50	112	7 2 6	5 5 1
S3, A3 ...	2 9 6	11·24	133	8 8 9	5 19 3
S3, A3, K½ ...	2 17 7	10·64	126	7 19 7	5 2 0

* Fertiliser freights, North Fremantle to Keysbrook, 7½d. per cwt ; Super., £3 15s. per ton ; Sulphate of Ammonia, £11 10s. 0d. per ton : Sulphate of Potash, £15 10s. 0d. per ton.

2. E. C. Melville—Wonnerup.

Soil.—Grey sandy loam, overlying clay, new land originally carrying red-gum and jarrah.

Preparation.—Ploughed in early spring and cross-ploughed, then harrowed; reploughed at time of planting; inter-tillage carried out during growing period.

Seed.—"Hickory King" sown at rate of 36 lbs. per acre.

TABLE 2.—RESULTS OF TRIALS: E. C. MELVILLE.

Fertiliser.	Cost of Fertiliser per acre plus freight.*	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 12 9	5·73	100	4 5 11	3 13 2
S3, A1 ...	1 4 9	8·27	146	6 4 0	4 19 3
S3, A2 ...	1 16 9	11·66	205	8 14 11	6 18 2
S3, A3 ...	2 8 9	15·14	266	11 7 1	8 18 4
S3, A3, K½ ...	2 16 9	16·25	285	12 3 9	9 7 0

* Fertiliser freight, Picton Junction to Wonnerup, 6d. per cwt.

3. J. H. Oldfield—Forest Grove.

Soil.—Light chocolate to grey sandy loam, originally timbered with karri and marri. The land was previously growing clover pasture.

Preparation.—Land ploughed and harrowed in the spring, and ploughed again at the time of planting. Inter-tillage was carried out during the growing period.

Seeding.—"Hickory King" maize seed was planted on the 26th November at the rate of 36 lbs. per acre in rows 36 inches apart.

Germination.—Generally poor but *very* poor germination on the heavily fertilised plots.

TABLE 3.—RESULTS OF TRIALS: J. H. OLDFIELD.

Fertiliser.	Cost of Fertiliser per acre plus freight.*	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 13 0	4·65	100	3 9 9	2 16 9
S3, A1 ...	1 5 1	8·07	173	6 1 0	4 15 11
S3, A2 ...	1 17 2	8·23	177	6 3 5	4 6 3
S3, A3 ...	2 9 3	8·07	173	6 1 0	3 11 9
S3, A3, K½ ...	2 17 4	7·25	156	5 8 9	2 11 5

* Fertiliser freight, Picton Junction to Forest Grove, 7d. per cwt.

TABLE 4.—AVERAGE RESULTS OF THE THREE EXPERIMENTS ON NON-IRRIGATED LAND.

Fertiliser.	Cost of Fertiliser per acre plus freight.	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 13 0	6·28	100	4 14 2	4 1 2
S3, A1 ...	1 5 0	8·71	139	6 10 8	5 5 8
S3, A2 ...	1 17 0	9·80	156	7 7 0	5 10 0
S3, A3 ...	2 9 0	11·48	183	8 12 2	6 3 2
S3, A3, K½ ...	2 17 3	11·38	181	8 10 4	5 13 1

The results were again affected this season by the extremely dry conditions which prevailed during the growing period.

TRIALS ON IRRIGATED LANDS.

1. T. B. Stanley—Brunswick.

Soil.—Grey to red loam originally timbered with redgum.

Preparation.—Ploughed in spring and reploughed prior to planting.

Seed.—"Hickory King" sown at rate of 36 lbs. per acre on 18/1/36.

Observations.—Weights taken on 30/3/36. The average height of the maize was about six feet. There had been a tendency to over-water during the growing period.

TABLE 5.—RESULTS OF TRIALS: T. B. STANLEY.

Fertiliser.	Cost of Fertiliser per acre plus freight.*	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 12 2	14·30	100	10 14 6	10 2 4
S3, A1 ...	1 3 11	14·56	101	10 19 5	9 15 6
S3, A2 ...	1 15 9	12·91	90	9 13 7	7 17 10
S3, A3 ...	2 7 6	12·30	86	9 4 6	6 17 0
S3, A3, K½ ...	2 15 6	18·25	128	13 13 9	10 18 3

* Fertiliser freight, Picton Junction to Brunswick, 3½d. per cwt.

2. O. Green—Harvey.

Soil.—Red clay loam originally timbered with redgum.

Preparation.—Ploughed in spring and cultivated; reploughed and worked again prior to planting.

Seed.—"Hickory King" seed sown at the rate of 36 lbs. per acre on the 9th to 19th February, 1936.

Very little variation in growth was obtained and the plots were weighed on 7/4/36.

TABLE 6.—RESULTS OF TRIALS: O. GREEN.

Fertiliser.	Cost of Fertiliser per acre plus freight.*	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 12 5	15·28	100	11 9 2	10 16 9
S3, A1 ...	1 4 3	12·44	81	9 16 7	8 12 4
S3, A2 ...	1 16 2	15·04	98	11 5 7	9 9 5
S3, A3 ...	2 8 0	13·86	91	10 7 11	7 19 11
S3, A3, K½ ...	2 16 1	13·10	86	9 16 6	7 0 5

* Fertiliser freight, Picton Junction to Harvey, 4½d. per cwt.

3. J. A. Baron-Hay—Wagerup.

Soil. -Light grey sandy loam not fallowed prior to planting. This land grew maize four years previously with an intermediate crop of pumpkins.

Seed.—"Hickory King" seed sown at rate of 35 lbs. per acre in rows 30 inches apart on January 25th and 26th.

The yields were taken on 24/4/36.

TABLE 7.—RESULTS OF TRIALS—J. A. BARON-HAY.

Fertiliser.	Cost of Fertiliser per acre plus freight.	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 12 8	12·00	100	9 0 0	8 7 4
S3, A1 ...	1 4 7	11·76	98	8 16 5	7 11 10
S3, A2 ...	1 16 7	13·34	111	10 0 0	8 3 5
S3, A3 ...	2 8 6	8·47	71	6 7 0	3 18 6
S3, A3, K½ ...	2 16 7	7·76	65	5 16 5	2 19 10

TABLE 8.—AVERAGE RESULTS OF THREE EXPERIMENTS ON IRRIGATED LAND.

Fertiliser.	Cost of Fertiliser per acre plus freight.	Average Yield per acre.	Percentage Yield.	Value of Yield per acre at 15s. per ton.	Value of Crop per acre less cost fertiliser and freight.
	£ s. d.	tons.	%	£ s. d.	£ s. d.
S3	0 12 5	13·86	100	10 7 11	9 15 6
S3, A1 ...	1 4 3	12·92	93	9 13 7	8 9 4
S3, A2 ...	1 16 2	13·76	99	10 6 5	8 10 3
S3, A3 ...	2 8 0	11·54	90	8 12 1	6 4 1
S3, A3, K½ ...	2 16 1	13·03	94	9 15 5	6 19 4

The foregoing results indicate:—

A. *Non-Irrigated Areas.*

1. That the addition of 1, 2 and 3 cwts. of sulphate ammonia to 3 cwts. of super gave heavier yields and were profitable.

2. That the addition of sulphate of potash to the 3 cwts. superphosphate and 3 cwts. ammonia treatment did not increase the yield.

3. At Wonnerup on new land of a grey sandy nature the addition of sulphate of potash gave increased profitable yields, as did the addition of 1, 2 and 3 cwts. sulphate of ammonia.

B. *Irrigated Areas.*

1. That the addition of sulphate ammonia in varying quantities to the superphosphate did not affect the yields of green material obtained.

2. That sulphate of potash gave increased profitable yields on T. B. Stanley's property at Brunswick.

AGRICULTURAL PROBLEMS

Agriculturists, pastoralists and primary producers generally, who may be having difficulties of any kind in connection with their production activities, are invited to communicate with the Agricultural Adviser of their district of the Department of Agriculture, when information and advice will be supplied free of charge.

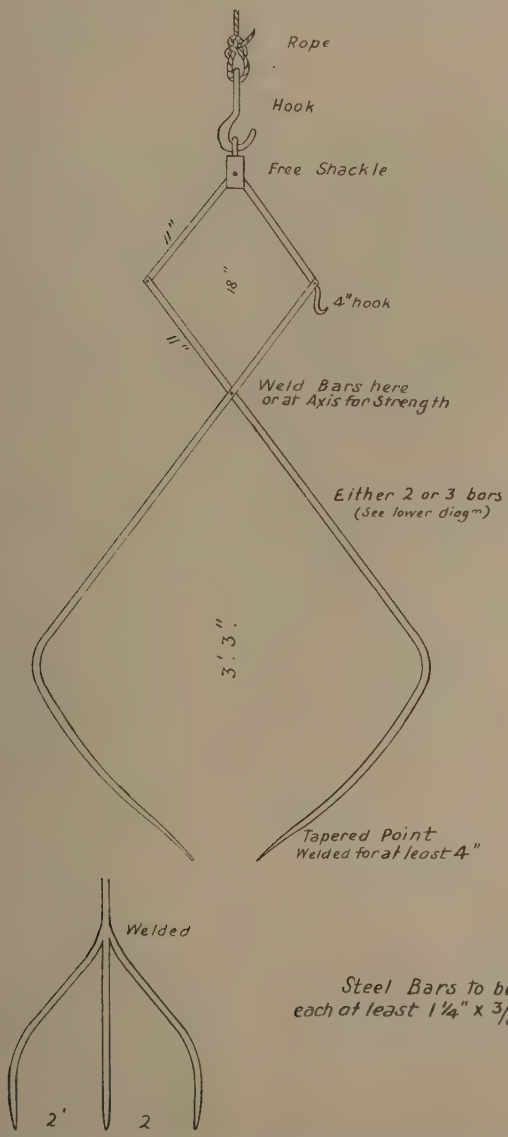
Where identification of plant or stock diseases or insect pests is required, full details of symptoms should be forwarded and also samples of the diseased plant, animal tissue or insect where practicable. Plant tissue intended for examination by the Plant Pathologist should be wrapped in paper and not forwarded in airtight containers, and plant specimens for the Botanist should be pressed between newspaper and dried before despatch. With regard to animal tissue for microscopic examination, this should be forwarded in a solution of 10 per cent. formalin, or if of considerable bulk in a sealed kerosene tin containing a few ounces of formalin as a preservative. Living insects should be sent in suitable containers and dead specimens in methylated spirits.

The addresses and names of Advisers are as follows:—

Albany	A. C. Vaughan.
Bridgetown	A. Flintoff.
Bunbury	M. Cullity.
Denmark	V. L. Cardon.
Geraldton	G. L. Throssell (Government Buildings).
Gosnells	R. C. Owen.
Harvey	D. L. Breen (Fruit); C. Giles (Dairying).
Katanning	A. S. Wild
Kalamunda-Roleystone	W. H. Read, c/o. Department of Agriculture, Perth.
Manjimup	K. W. Simes.
Metropolitan, Gingin, Chittering ...	S. E. Bennett, c/o. Department of Agriculture, Perth.
Metropolitan to Spearwood ...	R. L. Cailes, c/o. Department of Agriculture, Perth.
Mundaring	V. Cahill.
Narrogin	H. R. Powell.
Northam	F. L. Shier.
Northcliffe	H. S. Rogers.
Wasse	J. M. Nelson.

HOME-MADE GRAB.

H. G. ELLIOTT,
Agricultural Adviser, Department of Agriculture.



This illustration gives full particulars for making a grab for meadow hay or green material for use on the Hoist as illustrated in the "Journal of Agriculture," Volume 12, December, 1935, page 469.

DOWNY MILDEW (BLUE MOULD) OF TOBACCO AND ITS CONTROL BY MEANS OF BENZOL AND OTHER VOLATILE HYDROCARBONS.

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Plant Pathologist.

INTRODUCTORY.

According to the results of researches which have been conducted by D. B. Adam, formerly Plant Pathologist of the Victorian Department of Agriculture, and now occupying a similar position at the Waite Agricultural Research Institute in South Australia, it appears that the beginnings of the tobacco-growing industry in Australia were laid as long a time ago as approximately 1858, and that almost from its inception the tobacco crops were devastated by a disease which soon came to be known colloquially as "blue mould."(1)

It was not until 1890 that this disease was described as being caused by a fungus, by the name of *Peronospora* sp., by Tryon (1), nor till 1933 that Adam created a new species name *Peronospora tabacina* to designate the particular parasite concerned (2). As this parasite is a member of the group of fungi known scientifically as "downy mildews," the term "downy mildew" is now preferred for the disease, by scientists, rather than the older one "blue mould," more especially as the latter term conveys to the minds of scientifically-trained workers a suggestion that the cause of the disease belongs to an entirely different group of fungi. Also, the term "downy mildew" is very closely descriptive of the reproductive stages of the fungus, while the term "blue mould" is only more or less satisfactory as a descriptive term, as the colour of the fungal growth obvious on the diseased areas varies very considerably from time to time and place to place, and can rarely, if ever, be accurately designated "blue."

Downy mildew of tobacco appears to have caused much greater havoc in Australia over the past 75 years or so than in any other tobacco-growing country. This would appear to have resulted from the fact that the cause of the disease is endemic to Australia, being found in nature attacking the wild tobacco *Nicotiana suaveolens*, and a number of other native tobacco species which occur widespread throughout the interior portions of the continent (1, 2, 5, 10, 12).

In the United States of America the downy mildew disease was unimportant commercially until 1921, since when there have been several severe outbreaks (12), so that the disease would now appear to be firmly entrenched in the main tobacco-growing States of the Union.

ECONOMIC IMPORTANCE OF DOWNY MILDEW OF TOBACCO.

Downy mildew is the most disastrous disease with which the Australian tobacco-grower has to contend, wiping out, as it has with monotonous regularity year after year in Queensland, New South Wales, Victoria, South Australia, Western Australia and Tasmania, enormous numbers of plants in the seed-beds, and sometimes even after planting out.

The extremely serious nature of the trouble under favourable conditions may perhaps be best realised from the following quotations. In the "Report from the Select Committee on the Tobacco-growing Industry in Australia," 1929-30 (13), occurs the statement—"The growers have hitherto proved unable to deal with the blue mould disease, which in many cases wipes out the tobacco of a whole district two out of three seasons." Adam, writing in the Victorian "Journal of Agricul-

ture" for July, 1925, stated: "Frequently a tobacco seed-bed, containing thousands of plants in a condition ready for planting out, is ravaged to such an extent that every plant is affected. Growers, in the past, by cultivating a large number of seed-beds in different parts, especially in the hills, sought to avoid disease in some beds, and usually from these sufficient plants could be obtained for planting out purposes. A more serious problem has arisen lately in that the disease is not confined to the seed-bed, and quite large areas of planted-out tobacco in various stages of maturity have been ruined by it."

So serious had the disease become in Victoria during the past few years that, just prior to the discovery and announcement of the benzol treatment referred to below, the Victorian Department of Agriculture was seriously investigating the possibility of having disease-free tobacco seedlings raised in New Zealand (where the disease is still unknown) and transported, when ready for transplanting, into Victoria (7). Another suggestion was that tobacco seedlings for Victorian use might be raised free from downy mildew at Alice Springs in the Northern Territory.

Tobacco-growing is still in its infancy in Western Australia, but already we have experienced a number of disastrous outbreaks of the disease (8, 9, 10, 11). The first outbreak in this State was recorded in 1930 (8), and since then the disease has annually caused considerable havoc here.

CHARACTERISTICS OF THE DISEASE.

As shown by Darnell-Smith (5), a tobacco seedling may be infected in the very earliest stages, *i.e.*, when it has not yet developed its first true leaves but is still in the "cotyledon" or "seed-leaf" condition. From that time onwards, right throughout its life, it may fall a prey to the disease whenever the weather conditions become suitable to the development of the fungus and the plant happens to be in a susceptible condition, provided always that the fungus concerned (*Peronospora tabacina*) is present in the correct condition to cause infection. Many farmers and others appear to have the idea that "downy mildew" of tobacco can develop spontaneously out of the atmosphere as soon as the weather conditions become suitable. This is most definitely not so. The "downy mildew" disease can only develop if some stage of the "downy mildew" fungus (*Peronospora tabacina*) is already present in the environment when the weather or atmospheric conditions become suitable. The "downy mildew" fungus can only be begotten by the "downy mildew" fungus, just as, for example, sheep can only be begotten by sheep, or tobacco plants by previous tobacco plants.

For an outbreak of the "downy mildew" disease of tobacco three requirements are absolutely necessary, as follows:—

(1) The correct fungus (*Peronospora tabacina*) must be present;
(2) The weather or atmospheric conditions must be suitable for infection;
(3) The tobacco plants must be in a susceptible condition.

If any one of these requirements is not satisfied the disease cannot develop. In actual practice, "downy mildew" of tobacco is, in most instances, very largely a seed-bed disease, although—as shown above—it may at times cause very severe losses after the seedlings have been planted out. The causal fungus (*Peronospora tabacina*) is a member of the rather primitive group of fungi known as the *Peronosporales*, to which also belongs *Phytophthora infestans*, the cause of "Irish Blight" of the potato. All these fungi require abundance of moisture for their best development, and so it is only under the abnormally moist atmospheric conditions of the seed-bed that the disease is likely to be of much consequence in Western Australia. The "downy mildew" of tobacco appears to require very similar con-

ditions to those required by "Irish Blight" for its rapid and serious development, namely, warm, humid conditions during the day and rather cold air temperatures at night, or fairly rapid alternations of warm, humid, and cold weather. As, therefore, the climatic conditions in the South-Western area of this State are only very occasionally favourable to "Irish Blight," it would seem reasonable to suppose the

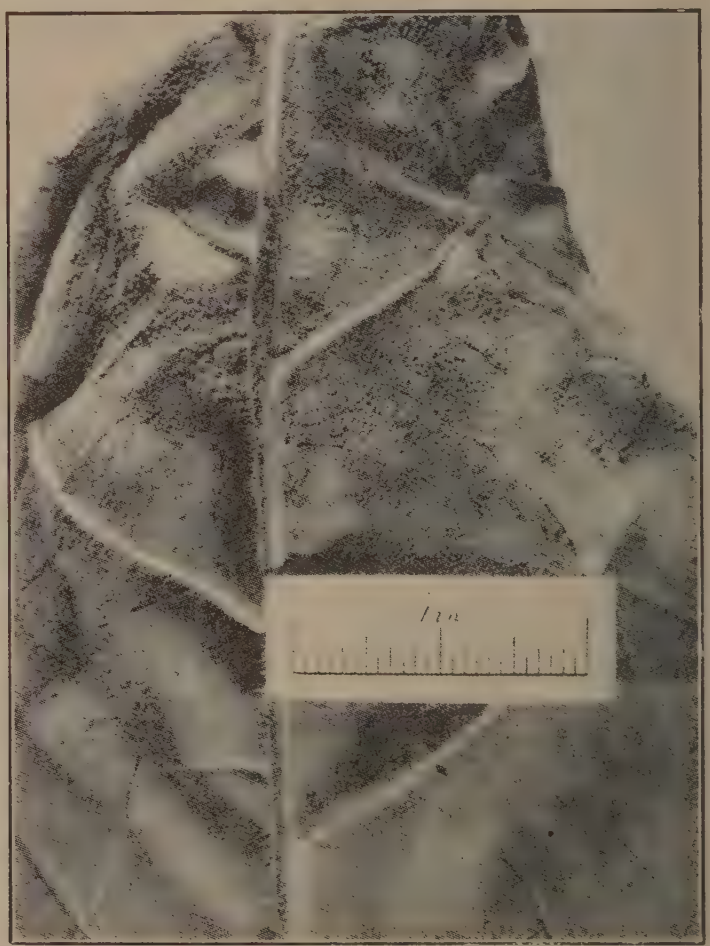

Fig. 1. Under-surface of tobacco leaf badly affected with downy mildew (*Peronospora tabacina* Adam), showing the characteristic shrivelling of the affected portions and the very copious production of white, greyish, or violet-tinted fruiting bodies (*conidiophores*) of the fungus on the under-surface. The lower right hand portion of the leaf is still healthy.

[After Mandelson, "Queensland Agric. Journal," August, 1931.]

same would apply to "downy mildew" of tobacco once the seedlings have been planted out. If Western Australian growers can manage to get their seedlings through the seed-bed stage in a healthy condition they should experience very little trouble with the disease in the field under normal climatic conditions.

SYMPTOMS SHOWN BY DISEASED PLANTS.

The most characteristic feature of affected plants is the development of a dense, white, greyish or purplish-grey down on the *underneath* portions of the diseased leaves. This downy substance is really composed of the fruiting-branches of the fungus loaded with the microscopic lemon-shaped or oval seed-bodies or *spores*. Under the microscope the fruiting structures (*conidiophores*) bear a rather striking resemblance to a dead, but still standing, karri tree, the spores being produced singly at the extremities of the many-forked branches. Under a strong hand-lens the mildew appears like a mass of densely-tangled whitish scrub. (The name "blue mould" was given to the disease on account of a very faint *violet or purplish* tint sometimes distinguishable in the fungal down, but the name does not seem to me very appropriate for reasons already indicated above.)

Looked at from *above*, affected leaves usually show no evidence of the "downy mildew" itself, but the diseased plants can generally be picked out by the occurrence of irregular yellow blotches on the leaves, mottled with bronzy or copper coloured spots, or by the drying-out and shrivelling-up of the diseased areas. Affected leaves are often a more or less uniform pale yellow in colour when looked at from above. Under conditions very favourable to the fungus the whole plant may soon wither up and completely collapse, but, should unfavourable conditions for the fungus ensue before this occurs, the plant may recover more or less completely until conditions are once again favourable for the further development of the parasite, when the disease may make further headway. Darnell-Smith (5) records that a plant once infected is always a potential source of infection, "for example, an infected plant kept in an isolated bush house produced a crop of spores in November, another crop in the following March, and a third crop in the following November." On the occurrence of the first recorded outbreak in this State (8) it was found that infection of the seedlings had almost certainly been brought about by the blowing of *conidia* (spores) from over-wintering diseased plants. These old plants on being examined were found in a number of cases to have several dead brown areas on a number of the bottom leaves. On the underneath surfaces of the dead tissues were found large numbers of the typical *Peronospora tabacina* conidiophores.

EXPERIMENTS IN THE CONTROL OF DOWNY MILDEW OF TOBACCO.

During the past few years a considerable amount of research work has been carried out in the various Australian States into possible means of controlling the ravages of downy mildew in tobacco seedlings while still in the seed-bed. As the parasite responsible for this disease is very closely related to those involved in a large number of other downy mildew diseases of various plants, which are characteristically controllable with considerable readiness with copper-containing sprays or dusts, it seemed reasonable to expect that the same response would be obtained in the case of the downy mildew disease of tobacco.

As a matter of fact, as a result of a very great deal of careful experimental work which has been carried out in this connection by L. F. Mandelson, Agricultural Research Officer of the Queensland Department of Agriculture (6), it has been found that, under Queensland and Northern New South Wales conditions, considerable success may be obtained by the use of—(a) home-made colloidal copper with soft soap as a spreader, or (b) copper emulsion. When these sprays were tested out by the Victorian Department of Agriculture, under the very different Victorian climatic conditions, they were not found very satisfactory, and their use outside of Queensland has not become general.

Just when it seemed that no satisfactory solution of the problem over Australia as a whole would ever be forthcoming, Dr. H. R. Angell, Senior Plant Pathologist, Division of Plant Industry, Council for Scientific and Industrial Research, Canberra, commenced, in a very small way, his experiments with benzol and other volatile hydrocarbons, which have led to the now widely adopted and miraculously successful method of raising tobacco seedlings in an atmosphere containing the gaseous phases of benzol, toluol or other suitable aromatic hydrocarbons.

This method was first announced by the Council for Scientific and Industrial Research to a Conference of Federal and State Tobacco Officers held in Canberra in July, 1935, full details of the experimental work and of the technique of the method being published in the Council for Scientific and Industrial Research Journal for August, 1935, in an article entitled "Downy Mildew of Tobacco: Its Control by Benzol and Toluol Vapours in Covered Seed-beds," over the names of H. R. Angell, A. V. Hill and J. M. Allan (3).

Fig. 2. Tobacco seed-beds as used by the Department of Agriculture, W.A., in Government House Grounds, Perth, during the spring of 1932. One bed not yet fitted with calico cover, although the wire to support same is in position. The beds were three feet wide. With "double width" calico (six feet wide) this width of bed gives an unnecessarily high ridge to the cover. With a bed four feet wide and the same width calico the ridge becomes only about a foot above the level of the soil in the centre of the bed, and such a bed is considered almost ideal. The calico can be fastened more or less permanently to one side of the bed and provided with sailmakers' eye-lets hooked over nails along the other, so that the cover can be thrown back on sunny days.

[Photo. by E. T. Morgan.]

Further experimental work on the benzol method is reported in the Council for Scientific and Industrial Research Journal for May, 1936 (4), from which the following extract is taken:—"When, in the autumn of 1935, extensive experiments on a practical scale in the tobacco district in north-east Victoria confirmed the results obtained in the laboratory and field at Canberra, the Departments of Agriculture in the various States decided to conduct trials during the seed-bed season of that year. In Victoria seed-beds were located at Myrtleford, Shepparton, Pomonal, and Walpeup. In every instance, seedlings raised under the vapours of benzol and toluol remained healthy. Adjacent beds, not so treated, were severely diseased. In South Australia, benzol was used by about a dozen growers, under the supervision of the departmental tobacco officer. All seedlings so raised were free from disease. Experiments under Western Australian conditions showed that

benzol, the petroleum fraction known as Solvent X3, and ordinary petrol were effective in preventing the disease. At Ashford, New South Wales, healthy seedlings were grown successfully by the use of benzol, toluol and petrol. Benzol, however, is the only substance that has been proved effective under all conditions."

THE BENZOL METHOD EXPLAINED.

The method of using the benzol treatment is to pour the benzol, which is a colourless, aromatic liquid, with initial and final boiling points at 70deg. C. and 98deg. C. respectively (3), obtained by the distillation of coal tar, into glass or metal containers, of such a size that from 1 to 2 square inches of evaporating surface will be available for every square foot of seed-bed. A considerable number of small containers distributed through the seed-bed are of greater value in controlling the disease than a few large ones. Care should be taken, when filling the containers, not to spill the chemical on the adjoining plants, as they will be injured by contact with the liquid.

Experience on the part of the Officers of the Council for Scientific and Industrial Research, who have been responsible for the development of the process, has indicated that square tins about 4¾in. x 4¾in. x 1¼in. deep are very satisfactory. It has been found that the maximum benefit is obtained from the use of the treatment when the containers used to hold the benzol are placed about nine times as far apart as the diameter of the containers, and the containers are somewhat elevated above the level of the plants. The benzol is to be poured into the tins, or other containers used, every night and at any other time when the waterproofed covers of the seed-beds are fastened down. The unevaporated benzol is removed in the morning so as to prevent wastage, or at any other time that the covers are taken off the seed beds. Should the weather be wet so that the covers are not removed for several days on end, the benzol is not removed during this period. No harm apparently results from leaving the benzol in the containers when the covers are removed and the seedlings are exposed to the sunlight. The only disadvantage which this procedure would have, so far as is known, is that a considerable amount of benzol would be wasted by evaporation. Experiments carried out in Victoria by W. J. B. McDonald, Inspector of Agriculture of the Victorian Department of Agriculture, during the seed-bed season of 1935 indicated that, with properly constructed and covered beds, approximately one pint of benzol was required for every square yard of seed-bed per week of treatment (7).

In some of the first experiments carried out by the Council for Scientific and Industrial Research it was the practice to introduce the benzol into the containers, from the time when the seedlings first developed from the seeds, until they were transplanted into the fields. It has been suggested, however, that, with a view to cutting down expense, it would possibly be satisfactory to delay the commencement of the benzol treatment until the seedlings had grown for a fortnight to a month or so after the germination of the seed. The reason for this is that it has been found that, generally speaking, the downy mildew disease does not attack the very young seedlings, but may cause great havoc several weeks or so before they would normally be transplanted into the fields. In other words, it is just about the time that the grower is thinking about getting ready to transplant his seedlings into the field that the disease usually breaks out.

In Western Australia, benzol is obtainable in 44-gallon drums at approximately 2s. 3d. per gallon f.o.r., Perth.

To effectively use the benzol treatment, it is necessary to have the seed-beds covered with calico or other suitable covers, which have been water-proofed with raw linseed oil or some other suitable material. Alternatively, glass-covered frames or frames covered with some satisfactory glass substitute, can be used. It

appears to be necessary that the covers shall be fairly well gas-tight, so that the vapour of the benzol will be retained sufficiently well to impregnate the whole of the atmosphere which surrounds the plants.

On the other hand, it is undesirable to block up any small cracks which may occur in the wooden sides of the seed-beds, as a too effective confining of the gas within the atmosphere of the seed-beds has been shown to cause a certain amount of injury to the plants (3, 4).

TOLUOL AND OTHER SUBSTITUTES FOR BENZOL.

Experiments in the Eastern States have shown that in lieu of benzol, "90 per cent. commercial Toluol" can be used instead with considerable success, and it has been suggested that in Queensland and Western Australia the toluol might prove quite satisfactory, owing to the higher temperatures which are experienced in these States during the raising of the seedlings, than occur in Victoria or Tasmania. The toluol has a higher boiling point than the benzol; the boiling point for toluol being approximately 110°C., whereas the boiling point for benzol is approximately 80°C.

Fig. 3. Close-up view of the bed shown in course of preparation in Fig. 2. The calico cover in this instance has been sewn on to the supporting wire, but this is not necessary or advisable. The cover has been thrown back on one side so as to expose the seedlings to sunlight.

[Photo. by E. T. Morgan.]

As it is possible that some growers may have difficulty in obtaining either of these substances, it should perhaps be pointed out that the experiments at Canberra have shown that ordinary petrol can be used with considerable advantage in preventing the spread of the disease, although it was not as reliable in preventing its outbreak as either of the other two materials mentioned. This is probably due to the fact that petrol consists of a mixture of hydro-carbons, many of which have a boiling point of up to 190°C. The Shell Oil Co., Perth, has pointed out to officers of the Department of Agriculture that it has available a material known as "X3 Solvent," the boiling point of which extends from 70-110°C. As this material contains from 55-60 per cent. of aromatic compounds, or "benzol equivalent," it was considered possible that this would be found satisfactory as a substitute for the genuine benzol. Experiments carried out at Manjimup by Tobacco Adviser A. Sharp, in 1935, to determine the possibility of using this material, are reported below.

EXPERIMENTAL WORK CARRIED OUT IN WESTERN AUSTRALIA IN 1935 ON THE BENZOL TREATMENT OF TOBACCO SEED-BEDS.

In connection with the experiments carried out at Manjimup, Western Australia, during the spring and summer months of the 1935-36 tobacco-growing season, Mr. Sharp writes: "Although downy mildew did not assume quite such a virulent form this year as it did the previous season, very few seed-beds escaped infection altogether by the end of the planting-out season. The first outbreak was reported from the Pemberton district on 30th September. A week later, an outbreak was reported from the Kojonup district on the Great Southern Railway, over 100 miles east of Manjimup, and well outside the tobacco growing areas. A few weeks later, it appeared in a seed-bed in one of the suburbs of Perth, nearly 200 miles from Manjimup.

"Owing to the exceptionally cold, wet conditions which obtained in the spring, seed-beds generally were very backward, many of the uncovered ones being a complete failure. Those which made most progress, owing to being covered, or to being situated in sheltered positions, almost invariably developed the disease during October, and most of the more backward ones became infected later on.

"The fact that the disease made its appearance quite early in the season in districts as far apart as Pemberton, Kojonup and Perth appears to indicate conclusively that mere isolation of seed-beds, and the growing of same away from the regular tobacco-growing district cannot be relied upon to control the disease. Several instances came under notice this season of beds established well out in the bush developing downy mildew early in October, whilst other beds much nearer to possible sources of infection remained clean until November. Much inconvenience and delay in planting out has been caused to growers this season, first by the very slow growth of seedlings, and second, by the fact that many seed-beds contracted downy mildew just before they were ready for transplanting. Observations over the last two seasons have led to the very definite conclusion that the rough-and-ready system practised by many growers of sowing seed-beds in the open without any cover, and trusting to luck that they will escape the effects of bad weather, frosts, insects, slugs and disease, will have to be abandoned in favour of a system of using covered beds, in which conditions can to some extent be made favourable for more rapid growth of the seedlings.

"In view of the success obtained at Canberra last autumn with benzol as a control for downy mildew, it was decided by the Department of Agriculture to try out the method at Manjimup this season on an experimental scale. Two series of seed-beds were established, one series in Manjimup itself, and the other one and a half miles out of the town. The hydrocarbons used were benzol, petrol and X3 Solvent. The last-named is a benzol substitute marketed by the Shell Oil Co of Australia.

DETAILS OF THE EXPERIMENTS.

"The seedlings were grown in cold frames similar to those used at Canberra (3). Each frame measured 5ft. 6ins. long by 4ft. 6ins. wide, sloping from 18ins. high at the back to 9ins. in front, and was covered with calico treated with raw linseed oil.

"The beds, 1½ miles from Manjimup, were sown on 20th August, and those in Manjimup on 5th September. Germination and growth were slow until well into October, owing to the cold, wet weather, and it was not until 25th October that the various hydrocarbons were introduced. In one series of beds one cold frame was treated with benzol, one with petrol, one with X3 Solvent, and two were

left not gassed as controls. Each frame undergoing treatment contained two tins, each 2 ins. square and 1½ ins. deep, set up on wood blocks ¾ins. above ground level, this giving one square inch of evaporating surface per square foot of seed bed. This is only half the concentration at first recommended by the Council for Scientific and Industrial Research, but was considered sufficient for West Australian conditions. The frames were made of green jarrah timber, which shrank somewhat after they were constructed. The gaps thus left between the boards were filled up with strips of hessian.

"The gas treatment was commenced on 25th October, 1935, all the beds being then apparently free from downy mildew. All the frames were artificially inoculated the following day by shaking infected plants all over them, and transplanting infected plants into them. On the morning of 6th November (11 days later), the first signs of downy mildew were visible in the control beds, but none was apparent in any of the others.

"The beds were treated in a manner similar to those at Canberra in the autumn of 1935. The hydrocarbons were introduced to the frames each night at the time when the covers were about to be closed, and removed in the morning when the covers were opened. In wet weather the covers were kept closed day and night and the boards were not removed. On several occasions the seedlings were subjected to as long as two days and three nights continuously under cover and in an atmosphere of gas, but in no case did they appear to suffer; in fact, they appeared to grow rather more rapidly under continuous cover than when uncovered. On several occasions, during dry weather, the frames were watered in the late afternoon, just before closing the covers. This was done in an attempt to make the conditions as favourable as possible for the spread of the disease, but in spite of this no sign of downy mildew appeared in any of the treated beds.

"The first of the seedlings were ready for transplanting at the beginning of November, but none were taken from the beds until 16th November, in order to make the test more thorough. The first picking of seedlings was planted out in one of the field experiment plots on that date and, when inspected a fortnight later, showed an excellent strike, with no sign of downy mildew. Two more small lots of seedlings were taken from the beds on 19th and 21st November and transplanted into a plot alongside the seed-beds. None of the materials used appeared to have any adverse effect on the seedlings, as a 100 per cent. strike was obtained in each case.

"Up to 20th December, 1935, at which date the plants in the control beds were almost completely wiped out, no plants in the beds treated with Benzol, X3 Solvent or A Grade Shell Petrol showed any signs of the disease, although the plants in these treated frames were then seriously crowding one another, and had grown up over the tops of the frames. So far as seed-bed observations were concerned, the experiments were discontinued at this date.

"In order to test whether the gas treatment had had any detrimental effect on the seedlings from the point of view of their ability to strike readily after transplanting, and then develop normally, a small plot of about 200 plants was planted out, the plot comprising plants which had been grown under all three of the gas treatments referred to above. A 100 per cent. strike was obtained without any difficulty, and the growth thereafter was strikingly uniform and vigorous, and in marked contrast to that frequently met with in commercial plantings where a certain amount of downy mildew has been experienced in the seed-beds.

"A number of the gas-treated seedlings were utilised in planting one of the fertiliser experiment plots on a property where downy mildew had necessitated a considerable amount of replanting in the rest of the field. Here again the vigour

and uniformity of the gas-treated plot was in marked contrast to the irregularity and patchiness observable in the remainder of the field, and this superiority was maintained right up to harvesting, in spite of the fact that there was a considerable amount of downy mildew present in the field. The leaf harvested from plants grown under gas cured in a perfectly normal manner.

"Early in the season growers whose beds contracted downy mildew were advised to try out petrol, as benzol was not then available in the State. Several growers covered their seed-beds more or less closely with hessian, some using several thicknesses. In every case they reported that the disease received a decided check. Later on, a supply of benzol became available, and several growers started using this. In no case were properly oiled covers used, the men concerned relying on untreated calico or several thicknesses of hessian. In one or two cases, where reasonably close covers were made, the treatment was successful, but in most cases the covering was not sufficiently airtight, and, although the disease was checked to a large extent, it was not altogether inhibited.

"An outstanding example of the successful application of benzol to commercial seed-beds during the 1935-36 season was observed in the case of G. F. Combs, Jardee, who covered three large seed-beds out of six with old superphosphate bags at night, and during wet weather, and introduced benzol in small tobacco and other tins of various shapes and sizes, according to my recommendations, before any sign of disease was seen in the beds. Shortly after the treatment was commenced, downy mildew broke out in the neighbouring untreated beds, with the result that the plants in these beds were wiped out, but no disease whatever appeared in the others, and the whole of Mr. Combs' crop, covering about 12 acres, was planted out with healthy seedlings from the gas-treated beds. The price of the benzol used for the three beds was 30/-, and Mr. Combs estimated that, had the treatment not been adopted, and all the beds had contracted the disease, the cost of obtaining seedlings elsewhere by purchase would have been not less than £30, assuming that they could have been obtained.

"Under the conditions prevailing during the 1935-36 season in Manjimup it appears, therefore, that either benzol, petrol, or X3 Solvent, used at a concentration of one square inch of evaporating surface per square foot of seed-bed in a properly constructed bed, with a treated calico cover, can be relied on to give absolute protection against downy mildew infection. Hessian or untreated calico covers, however, are unsatisfactory. One important disadvantage of using raw linseed oil as a proofing material is that it rots the calico very rapidly. It is suggested that a paraffin wax-petroleum jelly preparation might be equally effective, and have the effect of preserving the calico for a number of years.

"One or two other interesting points were noted in connection with these experimental beds. One rather important result of the use of the hydrocarbons was that insects and slugs disappeared from the seed-beds where these were used. The gases may have acted either as insecticides or repellants, possibly partly both. Another important point was that the covering of the seed-beds with oiled calico stimulated the growth of seedlings to a greater extent than covering with untreated calico. In the series of seed-beds in Manjimup, three frames were covered with untreated calico and two with oiled calico. All frames were sown on the same date and received similar treatment, but the plants under oiled calico were ready for transplanting about three weeks before those under untreated calico. This effect is due, no doubt, to the much warmer atmosphere maintained under the oiled calico.

"It is considered that October is the best month for transplanting tobacco in the Manjimup district. It is becoming increasingly evident every season that unprotected seed-beds cannot be relied upon to produce transplantable seedlings by

this time, owing to cold, wet weather, frosts, slugs and insects, to say nothing of downy mildew, and it is considered that the capital outlay involved in constructing seed-beds having sawn timber sides and ends, with closely-fitting, waterproofed, removable calico covers would be amply justified." This concludes Mr. Sharpe's report.

EXPERIENCE WITH BENZOL AND X3 SOLVENT, AUGUST, 1936.

On the 10th August, 1936, the writer was asked to visit a number of tobacco seed-beds located in the Fremantle area, Western Australia, in which it had been reported by the grower in charge that the downy mildew disease had apparently broken out. On investigation this proved to be the case, and steps were immediately taken by the owner of the seed-beds to inaugurate the benzol treatment. There were 23 seed-beds, in all, concerned, running parallel to each other at intervals of about a yard, each being 2ft. 6in. wide between the boards and 35 yards long. The soil had been piled up in each bed before the planting of the seed, so that there was

Fig. 4. Tobacco seed-beds of Michelides, Ltd., 20th August, 1936, showing, in each of the uncovered beds, two rows of tobacco tins in use in connection with the benzol treatment. Several beds at the left and right have had the calico covers replaced after filling up the tins with benzol.

[Photo. by Author.]

a pronounced slope on the soil from the back to the front of each bed. The back board of each bed stood approximately 6 inches high above the soil level inside the bed, and the front board about 4 inches to 5 inches higher than the soil within the bed at its front. The top of the back board being about 6 inches higher than the top of the front board, there was a fairly pronounced slope running almost parallel to the surface of the soil in each bed, when the unoiled heavy quality calico covers were stretched tightly across the frames. Owing to the fact that a fairly thick layer of artificial fertiliser had been placed about half an inch below the surface of the soil before the seed was planted, and also that it had been found necessary to water the seedlings twice a week with Cheshunt Mixture to check "damping-off,"

which broke out shortly after the seeds germinated, the plants were in a very soft and sappy condition when the downy mildew disease broke out. This softness in the plants had also been contributed to by the fact that for about a fortnight previously there had been only very short spells of sunshine interspersed between almost continuously warm to cool rainy weather, there being thus little opportunity for removing the covers from the beds during the day time.

As soon as the disease was identified the most seriously affected patches of plants were wiped out with very strong Cheshunt Mixture, but no great pains were taken to see that all the diseased plants were destroyed, as it was deemed inadvisable to run the very great risk of spreading the disease spores on the fingers, and incidentally waste time which could be more profitably employed in making arrangements for the obtaining and setting out in the beds of containers for the benzol, etc.

Round 2oz. tobacco tins with a diameter of almost 3 inches and a depth of approximately 1¼ inches, were set out in the beds in two rows, the distance between any two tins in a row being approximately three feet and the two rows being so placed with respect to one another that the tins from row to row had a "staggered" effect.

This arrangement gave an evaporating surface of benzol of approximately 1.7 square inches to every square foot of horizontal surface of seedbed. The round tins were kept on "an even keel" by being supported on the inverted bottoms of 2oz. flat, square, tobacco tins which were pushed into the soil so as to give horizontal surfaces.

When the supplies of benzol temporarily became exhausted recourse was had to "X3 Solvent" with apparently equally successful results.

The results to date have been miraculous. At the time of writing (16 days after the discovery of the infection) the downy mildew has made absolutely no progress in the dozen beds treated more or less promptly with the hydrocarbons, in spite of the fact that no attempt has been made to thin out the seedlings, which germinated extremely thickly; that the covers of the seed-beds are unoiled; that with the exception of one day in the whole of this period there has been hardly an hour of sunshine; that with the exception of the one day, it has been raining off and on during the whole of this period—sometimes in torrents; that the weather has been warm to cool as well as wet; that the covers let in the rain in considerable amounts; and that the softness of the plants is such as to make them (in the absence of the gas treatment) an easy prey to the disease.

In the treated beds no conidiophores of the fungus are to be seen. The disease has, however, become rampant in the remaining eleven beds into which the hydrocarbons were either not, or have only just been, placed, in spite of the fact that the seedlings in the control beds were, on the whole, less forward at the time of the outbreak than the plants in the gas-treated beds.

Truly with the aid of the benzol treatment a modern miracle has been performed.

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AN APPARATUS FOR THE APPLICATION OF BENZOL TO TOBACCO SEED-BEDS.

H. H. KRETCHMAR, B.Sc., A.A.C.I., F.C.S.

The writer's attention was drawn by the Plant Pathologist, Mr. H. A. Pittman, to the absence of a suitable method for applying benzol to tobacco seed-beds.

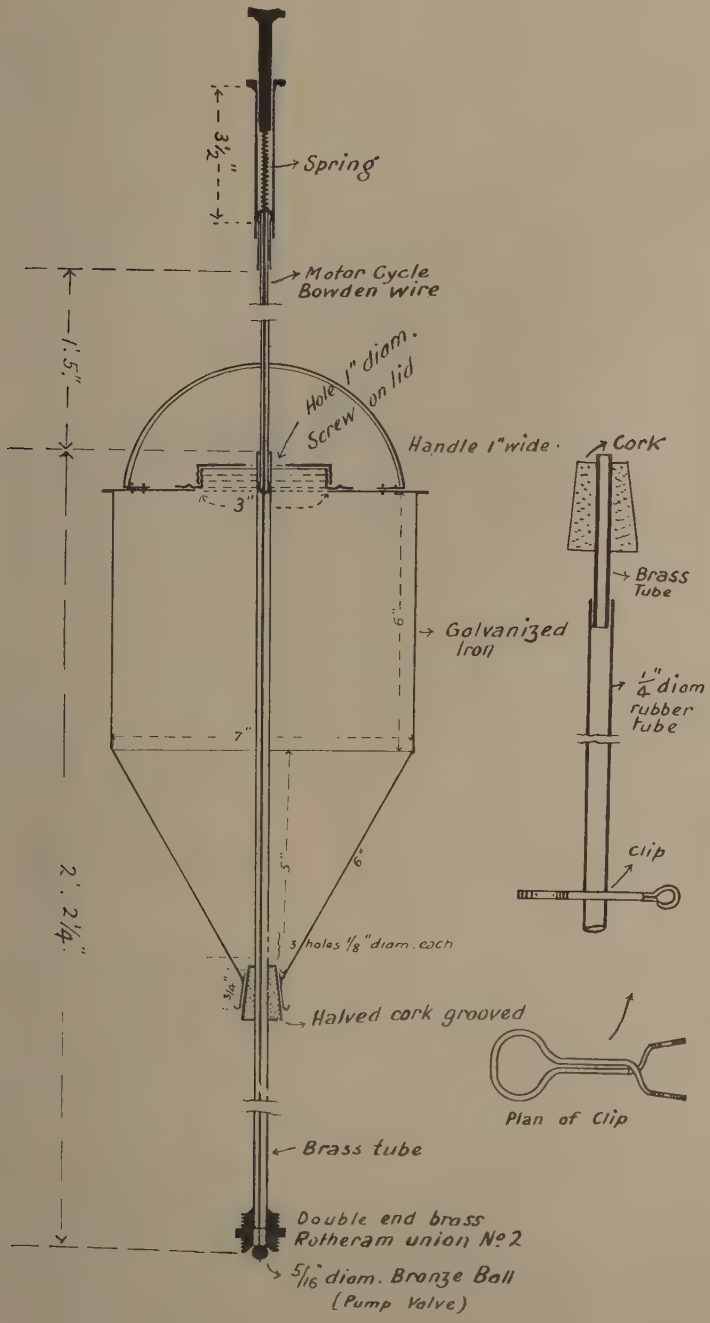
Any apparatus for this purpose must satisfy the following requirements:—

(a) Simplicity in handling;
(b) speed in action;
(c) freedom from spilling or splashing of the benzol;
(d) reasonable strength and durability;
(e) benzol capacity sufficient to fill a large number of benzol containers in the seed bed.

The object of this article is to describe an apparatus which was constructed and found to fulfil these requirements most efficiently.

(a) With one hand it can be easily carried and the nozzle directed into the benzol receptacle. When the nozzle has been placed in the receptacle one has only to press the release with the free hand and allow the benzol to run into the container until it is sufficiently filled. No stooping is necessary.

(b) In an experimental trial it was found possible to fill 50 seed-bed containers in 5 minutes.


3½"
Spring
Motor Cycle Bowden wire
1'5"
Hole 1" diam.
Screw on lid
Handle 1" wide
Cork
3"
Brass Tube
6"
Galvanized Iron
¼" diam rubber tube
7"
clip
5"
6"
2'. 2¼"
3 holes ⅛" diam. each
⅜"
Halved cork grooved
Plan of Clip
Brass tube
Double end brass Rotheram union No 2
5/16" diam. Bronze Ball
(Pump Valve)

(c) The benzol container is closed by a screw-on cap having a 1in. diameter hole in its centre to allow the release apparatus to pass through, thus the only open space is a very small one around the release apparatus at the top of the can and splashing is almost impossible. The shut-off valve is at the point of delivery of the benzol so that no dripping occurs when the valve is closed. It is essential that no benzol comes into contact with the plants as the liquid burns the young seedlings.

(d) The benzol container is made of heavy gauge galvanised iron and is consequently very strong and not easily dented. The delivery tube is made of sufficiently thick-walled brass tube to be reasonably strong, but if considered not as strong as necessary, this could be replaced by heavier material.

(e) The benzol container holds one gallon, i.e., 160 ozs., and as each receptacle may consist of a 2oz. tobacco tin or a tin of similar size, which holds 3oz. of fluid, it is possible to replenish about 50 tins with one fill of the benzol container.

Apparatus.

1. Benzol Container.—The attached drawing shows the shape of the container, together with the main dimensions. It is made to the same dimensions as a once common one-gallon oil tin, but there is fitted to what corresponds with the bottom of the oil tin a 3in. screw-on lid and a stout handle. Containers made to the dimensions shown, out of heavy gauge galvanised sheet iron may be purchased ready made.

2. Delivery Apparatus.—The main part consists of a piece of tube about 25in. long, 3/16in. internal diameter, 5/16in. external diameter. The writer found this a convenient length to use, but obviously persons of different height would prefer the tube of a length to suit themselves. The length should be such that when the benzol container is held with the arm hanging naturally at full length, the tube reaches from the top of the container to the ground. Twelve inches from the top of the tube a hole 1/8in. in diameter is drilled into it, with two similar holes about 3/8in. above and below the first hole. The centre piece of a Rotherham No. 2 double-end brass union is drilled out for half its length to fit over the delivery tube and then sweated on to it. It is essential not to scratch or otherwise malform the conical seat of the union at the end remote from the delivery tube. Three-quarters of an inch from the other end the tube is sawn through, a cap from the Bowden cable sweated inside the end as shown and then the short piece which was sawn off soldered back in place.

3. Release Apparatus.—This is made of a piece of brass tube 1/4in. internal diameter, 3/8in. external diameter and 3 1/2in. long. At the upper end it is fitted with a brass collar soldered on. The second cap from the Bowden cable is sweated into the lower end and then a piece of brass tube 3/4in. long (of the same size as the delivery tube) soldered to it. Inside the release tube fits a motor car carburettor spring. The release plunger is made of a piece of 1/4in. diameter brass rod having a collar soldered to its upper end as shown, and drilled at the lower end to a depth of about 1/2in. with a hole, into which is sweated the Bowden wire.

The assembling of the apparatus is performed as follows:—Firstly the Bowden wire is sweated into the end of the plunger. The spring is next slipped over the Bowden wire and the Bowden wire then passed through the release apparatus outer tube and manoeuvred about until the end passes through the soldered-in-cap. The wire may be then drawn through until the plunger enters

the outer casing. A length of Bowden cable cover, about 18in. long, is next passed over the wire, and the end carefully worked into the piece of tube at the lower end of the release until it enters the enclosed cap. It may be found necessary to ream the piece of the tube slightly larger in bore in order to manage this. The Bowden wire is next passed through the delivery tube: negotiating the Bowden cable cap may take a short time. When the Bowden cable cover is drawn up to the delivery tube, it is carefully manoeuvred into it until it passes into the cap. It may be necessary to enlarge the bore of the tube slightly with a reamer in order to insert the cable cover. The wire is then drawn tight until the plunger is drawn as far into its casing as it will go and a bronze ball 5/16ths inch diameter (such as is used for certain pump valves) and which has previously had a small hole drilled diametrically through it, threaded on to the wire and sweated to it about ½in. from the point where the wire leaves the union.

It is essential that the surface of the bronze ball be kept in perfect condition, free from scratches, etc., or it will fail to seal the delivery tube. On releasing the tension on the wire the spring in the release apparatus draws the ball into its seating, thus closing the delivery tube. The surplus cable below the bronze ball may now be cut off.

The delivery tube is most easily fitted to the benzol container by a cork first bored with a hole through which the tube passes with difficulty, and then cut in halves from end to end. The two pieces of cork are placed together around the tube about ½in. below the small entrance holes and the whole then inserted in the benzol container.

A very cheap alternative delivery arrangement is shown inset. This consists of a cork bored and fitted with a short length of brass tube 5/16ths inch external diameter and to which is fitted in turn a piece of ¼in. internal diameter hard rubber tube (gas tube). The delivery end of the rubber tube is closed by a spring burette clip such as chemists use. These clips can be obtained from the wholesale drug stores.

If it is decided to use this alternative arrangement it would be better to obtain the benzol container with a piece of tube of 5/16th inch external diameter about 2 inches long ready soldered to the bottom to be used in place of the cork and brass tube shown. On to this the rubber tube may be slipped directly.

A COMPARISON OF AUTUMN AND SPRING SOWING OF IRRIGATED PERMANENT PASTURE.

T. C. DUNNE and H. K. GIBSONE.

Except for small areas of summer moist land in the extreme south-west corner of the State, sowings for permanent pasture were, until the last few years, generally done during the autumn months.

Where seed-bed preparation was sufficiently delayed to enable germination of weeds before ploughing, it frequently occurred that satisfactory consolidation of the seed bed before sowing was not practicable, with the result that grazing was impossible before the following spring. On the other hand, where ploughing was done with the first winter rains, killing of weed growth was not achieved and the young germinating pasture suffered considerable competition from the adventitious growth.

Another factor seriously inhibiting the growth of clovers, was the presence, at this time of year, in large numbers, of the red-legged earth mite and the clover springtail.

Where irrigation was practised, spring planting offered a ready means of overcoming weed troubles and, to some extent, the depredations of insect pests. Owing to the heavy winter rains it was, however, frequently late in the season before soil cultivation could be commenced. The success of spring planting, if late, was entirely dependent on the spring rains, which are rather unreliable after the beginning of October.

Previous experience has shown that spring planting was absolutely precluded wherever couch grass was present, owing to the vigorous competition set up by this species which, under irrigation conditions, spreads so rapidly during the warmer months.

EXPERIMENTAL.

In 1934, experiments were commenced to compare the values of autumn and spring sowings of permanent pasture and to observe the factors making for success or failure in each instance

Areas of six acres each were selected on three different soil types. All blocks had grown subterranean clover for some years. None of these areas had previously been irrigated. Two of the sites chosen were at Brunswick Junction and one at Dardanup.

Of the selected plots, three acres of each were sown in the autumn and the remaining three acres the following spring.

Seed and Fertiliser.

The seeding of the plots was as follows:—

Hawke's Bay Mother Strain Perennial Rye Grass ..	10 lbs./ac.
New Zealand Certified White Clover	2 lbs./ac.

Superphosphate 1 cwt. per acre and Sulphate of Ammonia ½ cwt. per acre were applied at the time of seeding. Similar fertiliser applications were made the following spring and autumn. From the spring of 1935 onwards, superphosphate only was applied at the rate of 4 cwt. per annum.

Details of Plots.

1. BRUNSWICK A.—Soil: Reddish loam overlying a friable clay loam at a depth of 9-18 inches.

(a) Autumn sown—

The plot was watered in March and a good germination of grass and clover obtained. This growth was left for some weeks when it was grazed and then ploughed.

A good seed bed was made and sowing was done on May 29, 1934. Heavy rains fell immediately after sowing and part of the area became waterlogged. This caused poor germination of the grass and clover on a section of the plot. During the winter a thick stand of water weed developed in the wet area.

During the late spring both the rye grass and the white clover began to make rapid growth and by the time of the first irrigation a good stand had resulted.

Further drainage was effected and the pasture has since given very satisfactory returns.

(b) Spring sown—

A good seed bed was obtained and seeding was done on September 21, 1934. The germination was satisfactory and good growth followed.

The plants were showing the effects of insufficient moisture by the time water was available for the first irrigation but were not seriously affected. Good growth has been obtained since that time.

2. DARDANUP.—Soil: A chocolate loam overlying a friable clay loam at a depth of 18-42 inches.

(a) Autumn sown—

The seed bed preparation was good and the plot was sown on May 29, 1934. The plot suffered badly from lack of drainage and the germination generally was poor. In addition the white clover was considerably affected by the presence of red-legged earth mite and clover springtail.

A large amount of water weed developed during the winter months. The rye grass made little growth and few plants of white clover were to be found.

The pasture improved during the following summer and autumn, but the white clover, though improving, is still poor.

(b) Spring sown—

This plot had remained as fallow during the winter, but owing to wet conditions it was mid-September before cultivation was commenced A satisfactory seed bed was secured and seeding done on October 4, 1934.

Owing to some delay in obtaining water for the first irrigation, which was done the first week in December, the young plants suffered somewhat from drought, the clover being particularly affected. Considerable recovery was made during the late summer, and the pasture has since been satisfactory.

3. BRUNSWICK B.—Soil: A sandy surface underlain by a fairly friable clay loam at a depth of 6-12 inches.

(a) Autumn sown—

An excellent seed bed was prepared and sowing was done on May 28, 1934. The germination was good.

During the winter a fair amount of water ran on the area, but the firm seed bed obtained, by allowing the water to run over the surface, prevented waterlogged conditions.

During the summer of 1935-36 some scalding of the clover occurred during watering, but the recovery was rapid. The plot has generally been satisfactory.

(b) Spring sown—

The seed bed prepared for this plot was not as good as that for the autumn sowing. Seeding was not possible until October 12, 1934, but a good germination was secured.

During the summer of 1934-35, seepage from an irrigation channel caused waterlogging of the plot. Most of the white clover and some of the rye grass were killed.

The plot has since suffered considerably from insufficient drainage. The rye grass plants are relatively sparse, though individually well grown, and there is practically no white clover.

Results.

The plots were fenced to allow for individual grazing. The two Brunswick experiments were grazed by cows and the Dardanup experiment by cows and sheep.

A record of the hours of grazing obtained from each plot was kept. The two plots of each experiment were treated in a similar manner so that a direct comparison can be made between the autumn and spring sowings in each separate experiment.

In the case of the experiment, Brunswick B, the method of grazing has been such that the figures obtained suggest a much higher carrying capacity than is actually the case. In this instance the data only serve for the purpose of a comparison of the two plots.

It is believed that the figures obtained from the other experiments, Brunswick A and Dardanup, represent the true carrying capacity of the plots.

In view of the fact that grazing is generally obtained from the spring-sown pastures more quickly than from the autumn-sown pastures, for the purpose of comparison, the carrying capacity has been worked out from the time of planting in each case.

Grazing Data—Cow Hours from 3 Acres.

	Brunswick A		Dardanup *		Brunswick B	
	Autumn.	Spring.	Autumn.	Spring.	Autumn.	Spring.
1934.						
August ..	200	—	—	—	—	—
September ..	630	—	—	—	—	—
October ..	1,070	—	—	—	—	—
November ..	1,505	—	784	—	1,612	—
December ..	295	453	324	—	1,170	—
1935.						
January ..	250	212	1,251	335	1,755	2,480
February ..	300	283	795	920	1,687	1,207
March ..	768	720	1,025	1,212	1,632	776
April ..	480	384	703	—	504	584
May ..	550	550	464	1,237	435	360
June ..	—	—	—	342	1,752	1,421
July ..	600	480	—	—	750	—
August ..	480	576	—	—	898	96
September ..	768	864	194	194	1,495	980
October ..	1,512	1,080	216	360	1,330	432
November ..	1,512	648	628	900	736	560
December ..	1,083	1,353	736	990	928	720
1936.						
January ..	1,137	887	1,140	1,492	1,144	880
February ..	846	654	348	492	960	920
March ..	975	708	684	1,206	1,722	1,395
April ..	528	447	1,308	828	189	112
Total cow hours	15,489	10,299	13,125	10,508	20,699	12,919
Carrying capacity cows per acre (period—planting to April, 1936)	.92	.89	.78	.90	1.23	.93

*8 sheep = 1 cow.

Discussion.

The results from the Brunswick A experiment show that little difference in grazing was obtained from the autumn and spring sowings. Recovery was rapid from the small waterlogging area of the autumn plot and from the dry period experienced by the spring plot. The pastures are both satisfactory and the figures indicate that good results may be secured by planting at either period of the year.

The Dardanup experiment gives results definitely in favour of the spring planting. However, the low figure obtained for the autumn-sown plot reflects the relatively small amount of white clover in the pasture throughout the period under review. As noted previously, this was mainly due to the unfavourable conditions resulting from insufficient drainage.

Observations of the above experiments indicate that owing to poorer germination or failure to survive the winter, fewer plants of rye grass are present on the autumn-sown plots than on those sown in spring, but that the plants are larger.

It is considered that the records from the Brunswick B experiment give a carrying capacity figure about 50 per cent. greater than was actually obtained. However, as noted above, the figures from the two plots are comparable.

The lack of clover in the spring-sown plot, owing to the inundation of the pasture in the early stages, is reflected in the figures obtained. The autumn-sown plot is considered satisfactory.

Conclusions.

From the experiments reviewed it would appear that, providing the conditions are not unduly unfavourable, a satisfactory stand of rye grass may be secured by planting either in autumn or in spring.

On the other hand, the rapid establishment of white clover is dependent on reasonably favourable conditions. In this connection, care must be taken to avoid excessive waterlogging and weed competition with autumn planting. With spring-sown pastures, early planting is necessary in order that the clover may be sufficiently well rooted to withstand a dry period. Furthermore, in the season of planting, it is essential that the first irrigation be applied as early as possible.

Clover springtail and red-legged earth mite often cause considerable damage to young clover plants. These pests are usually more troublesome with the autumn than with the spring planting.

Recommendations.

(a) Autumn planting—

The preparation of the seed bed should be begun as soon as a fair proportion of the weeds have germinated.

Every effort should be made to obtain a very firm seed bed before sowing.

Care should be taken that the area is efficiently drained.

Planting should be done before the end of May and preferably about the middle of that month.

(b) Spring planting—

Seed bed preparation should begin as soon as the land can be worked and a firm seed bed obtained.

Planting should be done as early as possible, preferably about the first week in September. On no account should seeding be delayed later than the end of September.

Arrangements should be made to obtain water for the first irrigation as early as possible.

SILAGE, ENSILAGE AND SILOS.

(Revised.)

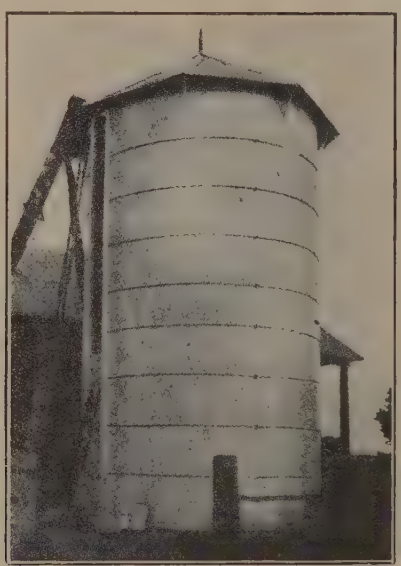
GEO. L. SUTTON,
Director of Agriculture.

The meaning of silage, ensilage and silo.

The words "Silage" and "Ensilage" are sometimes regarded as having the same meaning, and therefore as being interchangeable. This is not so.

Silage is green forage—natural or cultivated—which has been conserved in succulent form.

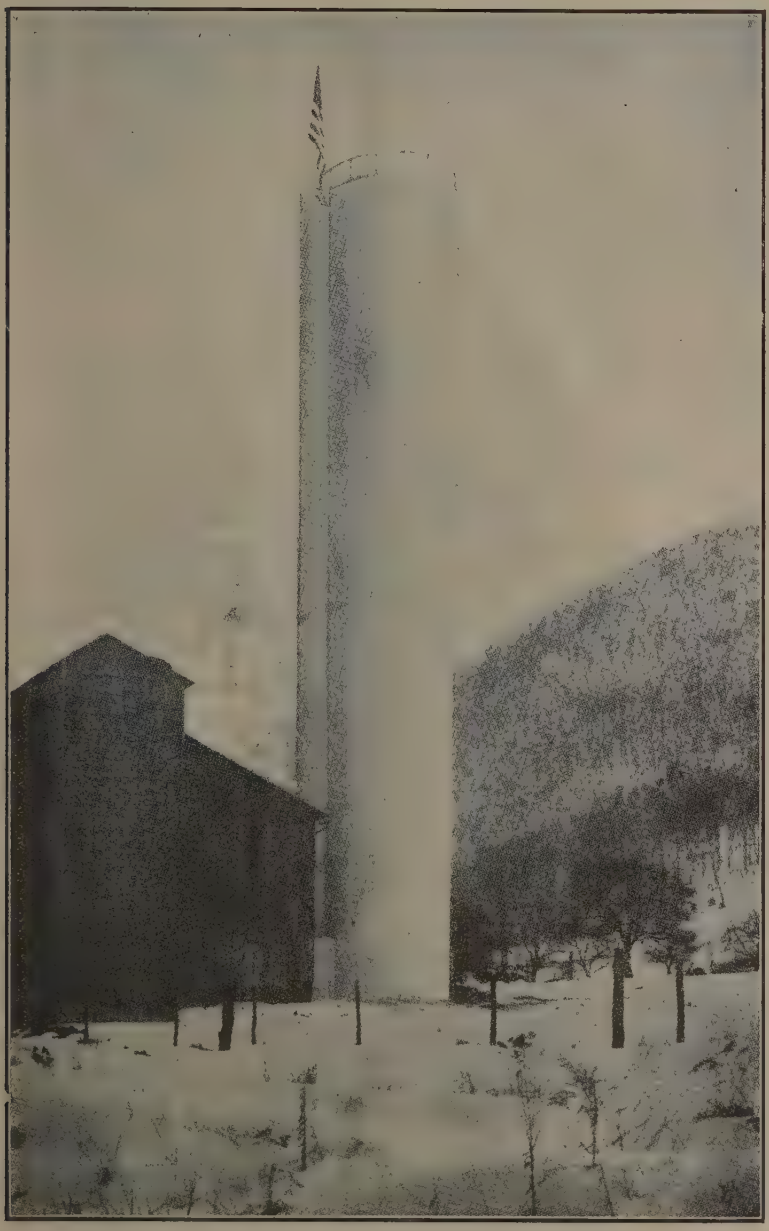
Ensilage is the process by which such forage is preserved—almost in its natural state—by the exclusion of air.



A dairyman's 100-ton "stave" silo.

A silo, which originally meant a pit or hole in the ground for keeping grain, now implies any sort of receptacle above or below ground for storing or preserving agricultural produce.

When a mass of green forage is exposed to the air it will become hot, and will then either dry out or rot. If, however, the air be excluded—by pressure, or in some other way—the material is preserved, and it becomes silage and will have what are now regarded as its distinctive characteristics of succulence, colour, taste, and smell. The silage will be quite as moist, and is usually a little moister, than the material from which it was made; the colour, however, will be altered, and may vary from a pale yellow or olive green to a very dark brown, almost black. All kinds of silage have a sour taste; some have also a more or less pronounced acid smell, and some an objectionable aroma.



THE WORLD'S TALLEST SILO 16ft. x 108ft.
Owners, Quality Farm Products Company, Salona, Pa.
(By courtesy the Polk-Genung-Polk Company.)

Silage is in effect "pickled" green fodder.

To many farmers the process whereby green forage is converted into silage is at first astonishing. To them hay-making is simple and understandable; the green stuff is dried and it keeps, but the conservation of greenstuff in a succulent condition has an element of mystery about it. They know that damp partially cured hay, if stacked, is likely to burn, and therefore expect a mass of much greener and consequently damper material also to catch fire, particularly as the mass usually and quickly becomes very hot. When it fails to burn, because of their experience with damp straw and stable manure, they expect it to rot, instead of which, when properly handled, it does neither. Apparently in some mysterious way it is preserved with all its succulence and food value, and retained in a form extremely palatable to stock, and on which they, particularly milking animals, do extremely well.

By consideration of what takes place when a mass of green foliage is put together, this apparent mystery can be removed from the making of silage. It is important that this should be done, for silage is such an important factor in a dairyman's success that any obstacle which stands in the way of the making of silage as a regular phase of his annual routine should be removed. There is really no reason why silage-making should not become as common-place as hay-making and cease to arouse any special comment. It is advisable, however, to understand what happens during the process and thus be in a position to secure best results.

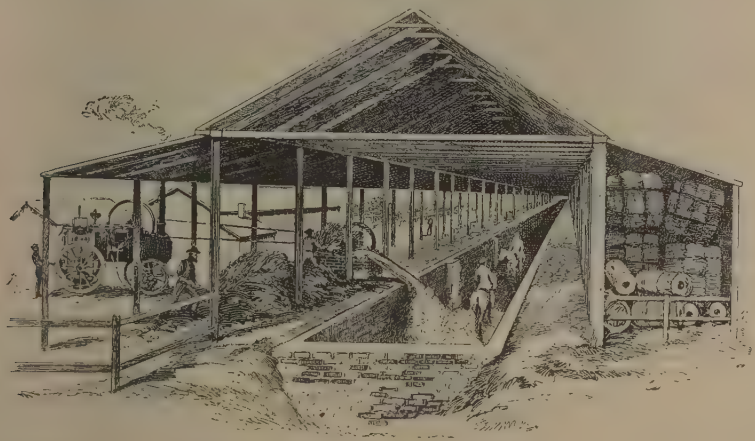
It is generally recognised that while the green plant is attached to its root it is a living organism, but it is not so well known that its plant cells will continue to live and breathe after the above-ground portion has been cut and separated from the roots. This, however, is so. When a number of newly cut green plants are placed together in a mass, this mass will become hot as the result of the breathing action of the still living plant cells, and the chemical changes resulting from bacterial activity. The degree of heat developed will depend upon the size of the heap of greenstuff, and to a large extent upon the amount of oxygen, as supplied by the air, available to the plants. The heat may become so great as to blacken and even char the plant tissues. If the supply of air available to the plants is limited by pressure or in other ways, the plants will quickly die by suffocation and the rise in temperature will not be great. If the supply of air is plentiful the plants will live longer and the heat developed will eventually be great enough to kill the plant cells. The result in all cases is the same, that is, the plants are killed, and if no steps are taken to exclude the air then the material will either dry out or rot, but it does *not* burn as some would expect. One of the several reasons for the failure to burn is that the heat generated by the oxidation of the plant tissues is not great enough to reach the combustion point of the greenstuff.

The rotting which takes place in the absence of drying is caused by micro-organisms present in the air and on the green material, which, under moist and warm conditions, bring about putrefaction and decay.

If, however, the admission of air is prevented by pressure, as in the case of the silage stack, or by the impervious wall and facilities for settlement as in the case of the above-ground silo and pit, the activities of the moulds and bacteria which cause decay are hindered or stopped, and those of another type of bacteria encouraged. The result of the work of the latter is that fermentation takes place, as in wine-making; but it proceeds a stage further and acids instead of alcohols are produced. These continue to be formed, mainly in the absence of air, until the amount of acidity present is equivalent to 1½ per cent. to 2 per cent. of the total mass of the material. When this concentration is reached their activity ceases and the acids present preserve or "pickle" the green forage, just as acetic acid, in

the form of vinegar, preserves vegetables which, when so preserved, are known as "pickles." This explains why, as might be anticipated, the material does not rot. The same preserving or pickling effect could be obtained by spraying the material, as packed, with sulphuric or hydrochloric acid, and in fact such a plan is the basis of a method successfully adopted in Finland; it is known as the A.I.V. method, these being the initials of Arthuri I. Vertanen, the inventor of this process.

Because the preservation of silage is due to the presence of one or more acids, one of which very often is acetic acid, the chemical name for the acid in vinegar, all silage has an acid or sour taste. Some, but not all silage, has also a distinct acid smell; acetic and butyric acids are volatile and have characteristic smells, others like lactic acid—one of the most desirable acids found in silage—are not volatile and, therefore, have no smell. The presence of acetic acid is not detrimental, nor is its smell objectionable; it gives the distinctive title of acid to the silage in which it and related acids are in excess of the non-volatile acids. Butyric acid, however, has the very offensive smell of rancid butter, and though the stock may eat silage which has developed this smell, such silage is inferior.



Underground Silo constructed at Rooty Hill, N.S.W., by Mr. Walter Lamb, and said to be the site of the first silage made in Australia.

The kind of acid which is produced in the silage is governed by the presence or absence of air, *and* the temperature reached during the process. The bacteria responsible for the formation of butyric and lactic acid function in the absence of air, whilst the acetic and allied acids require air for their development. With regard to temperature, butyric acid bacteria work best at temperatures ranging from 95deg. to 105deg. F., and the acetic acid bacteria from 70deg. to 78deg., the lactic acid bacteria have a wider range commencing at the lower temperature of 48deg. and extending to 95deg. F. (Another type of lactic acid bacteria has a much higher range, viz., from 105deg. to 120deg. F.)

The presence of butyric acid, as indicated by its unpleasant smell, besides being objectionable, also indicates that the process of preservation has been defective and that the silage has been partially spoilt. It is, therefore, obviously desirable to prevent its formation. As it can be formed only when the temperature exceeds 95deg. F., it follows that strenuous efforts should be made to keep the temperature below that point; indeed it should be kept as low as possible, for reasons to be stated later.

Historical.

The making of silage is probably of great antiquity. There is no doubt that grain was preserved in pits by the ancient Persians and Romans, and Professor McBryde, reasoning from historic data collected by him, has drawn the inference that green crops were preserved also. Certainly in the early part of last century the pitting of green crops, including sugar beet tops, was practised by the farmers of several European countries.

It is recorded that silage making was introduced into America in 1875 by Mr. Manly Miles, of Michigan, and that the first silo was built in 1876 by a Mr. Morris, of Maryland, as the result of reading the reports of trials conducted in France by M. Auguste Goffart, who had thoroughly described his methods in a publication issued at an earlier date, and entitled "Manuel de la Culture et del' Ensilage des Mais et d'autres Fourrages vert" (the Cultivation of Maize, and the Preservation of it and other Green Forage Crops as Silage).

The practice was introduced into England in 1882, largely as the result of a visit of the Vicomte de Chezelles, who had constructed in France a silo capable of holding 1,000 tons of silage, and who, whilst at the Royal Agricultural Society's Show at Reading, gave details as to his methods.

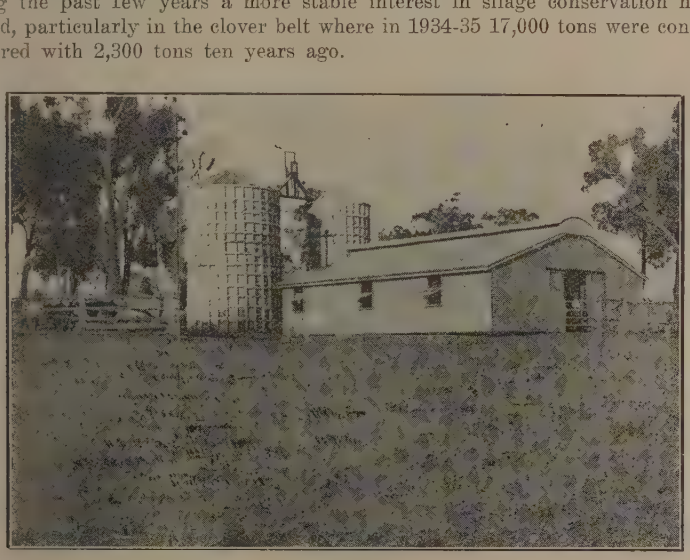
Silage was also introduced into Australia shortly afterwards, for in "Practical Dairying for Australia" (1893), Dowling records "the first agriculturalist to introduce silage in a business-like form in Australia was Mr. Walter Lamb, of Rooty Hill and Liverpool Plains, New South Wales." The actual date is not given, but the context implies that it was about 1883.

In the "W.A. Agricultural Journal" for July, 1901, it is stated that "Mr. A. W. Bolden wrote from Peak Hill on June 13, 'According to a promise made some twelve months ago, I am writing to tell you that the silage made by me in a pit turned out very well indeed.'" This is the earliest reference found regarding silage made in Western Australia, and presumably to Mr. Bolden must be given the honour of being the pioneer in this connection for having made silage some time in 1900.

The first "above ground" silo in Western Australia was probably erected at the Narrogin School of Agriculture in 1904, though about the same time a round brick silo was also built at Burekup by Mr. Frank Venn. The one at Narrogin was built of stone, it was 12 feet in diameter, and 20 feet high. In 1907 two larger silos of the modern American type, and constructed of wood and lined with galvanised iron were erected at the Narrogin School of Agriculture, and a few months later two similar silos were erected at the Brunswick State Farm. About this time several silos were also erected by farmers, but following this date no special interest was taken in silage in this State until about 1920, when a great stimulus was given to silo construction and silage making, consequent upon the increased attention being given to dairying and the essential association of silage with that industry.

A boom in silage making followed its introduction into both Great Britain and America, but with quite different subsequent results. In America is has been followed by the general and permanent adoption of the practice as a feature of farm economy, and in consequence most American farms are now equipped with one or more silos, the total number of which exceeds six hundred thousand. In Great Britain the great expectations at its introduction have not been realised, and the practice of silage making is anything but general. The position in 1909 was described by Professor M. J. R. Dunstan, who then wrote, "In 1882, when ensilage was being boomed, large sums were expended on special buildings and plant, and at the present day most of these are either used for other purposes or discarded, and where the practice is adopted the cheaper and equally serviceable American silos are used."

As in Great Britain and America, a boom in silo construction and silage making occurred in W.A. about 1920, consequent upon the interest in fodder conservation for sheep and cattle. Later the interest in this method of fodder conservation declined in the wheat and sheep areas and expensive silos are to be found unused. During the past few years a more stable interest in silage conservation has developed, particularly in the clover belt where in 1934-35 17,000 tons were conserved compared with 2,300 tons ten years ago.



Above-ground wood and galvanised iron silos at the Narrogin School of Agriculture, erected 1907, and probably the first of the modern silos erected in Western Australia.

The reason for the relative popularity of silage in America and Great Britain.

The explanation of this entirely different attitude in America and Great Britain towards the conservation of fodder as silage is not far to seek, and is due to the different conditions—climatic and otherwise—which influence the farm practice of the respective countries. In both countries the conservation of fodder in both the dry and the succulent form is essential for winter feeding, and again in both, the dry food is conserved in the form of clover and grass hay. In Great Britain root crops are of such cultural importance, can be so cheaply grown and easily stored, and are so reasonably certain, that they form a ready means for supplying the succulent stock foods necessary, and in consequence it is mainly where roots are an expensive or uncertain crop that silage takes their place in Great Britain.

On the other hand in America, though roots can be grown over a large portion of the agricultural area, maize is the principal crop, and can be grown more cheaply than roots. Though the maize plant can be conserved in a dry state as "maize hay" or "fodder maize," the process, because of the thickness of the maize stalks, is a somewhat lengthy one, and because of this there is a considerable risk of the loss of an undue proportion of its food constituents during the curing process. On the other hand the green maize plant, because of its solid succulent stalks, can be readily conserved as silage, and with suitable machinery more cheaply than as "maize hay" or "fodder maize," also with less risk of loss of its food constituents. Ensilage is thus the obvious process by which the principal American crop—maize —should be conserved. It is less difficult and more cheaply conserved in this way,

and as silage it provides the essential succulence for winter feeding. These facts easily account for the popularity of the silo and the extensive manner in which it has been permanently adopted as part of the American farm equipment.

Over the greater part of the agricultural area of Australia roots are relatively costly to grow, and in consequence the required succulence in conserved fodders will be obtained more cheaply in silage—though not necessarily maize silage—as in America, than in roots as in Great Britain.

Ensilage does not increase the food value of fodders.

When silage was first introduced into Great Britain, America and Australia many exaggerated statements were made regarding it. It was, and in some quarters still is, quite commonly believed that silage was better than the fodder from which it was made, and further, that weeds and other rubbish if made into silage would turn out first-class fodder; in fact at one time weeds, *e.g.*, thistles, were regarded by the majority of Australian agriculturalists as being the most suitable, and the proper material from which to make silage. These extravagant claims were fallacies, for though it is true that in the case of plants, like thistles, the spines became softer after being in the stack or silo, and the material in consequence is more palatable, the very fact of the material becoming hot involves loss, as will be explained, of carbo-hydrates and proteins. Silage even under the best conditions has never a food value quite equal to the material from which it is made, though some of the products formed may stimulate milk production to a greater extent than the original fodder.

The changes during ensilage.

For well over half a century investigations have been conducted with the object of determining what changes take place during ensilage, and the causes thereof. At the outset of these investigations it was found that during ensilage there was a loss of nutrients. Later investigations have confirmed this, but have also shown that the large losses of dry matter, which were originally found, may be so considerably reduced with better methods, that the loss of dry matter in a properly constructed silo need be very little, if any, more than when the same crops are made into hay.

One of the earliest current hypotheses regarding the causes of the changes which take place during ensilage was that they were due to bacterial activity. The American investigators Babcock and Russell, by results reported about 1902, proved that perfectly good silage could be made in the presence of ether or chloroform, and therefore that bacterial activity was not essential to its production.* These workers also showed that good silage could be made with much lower temperature than had been considered necessary.

In the *Journal of Agricultural Science* for July, 1908, Dr. E. J. Russell records the results of his investigations into "The Chemical Changes Taking Place during the Ensilage of Maize." For this purpose green maize was packed into bottles, and treated in different ways. The bottles acted as miniature silos, provision being made for the exclusion of air, and for the escape of gases. Further, some bottles were not sealed, and the results with these last showed that the admission of air caused putrefaction and the material rotted, thus proving that the exclusion of air is essential to the preservation of the silage which has been formed as the result of the other changes in the green material.

As the green plants from which silage is made consist of plant cells which continue to respire for some time after ensilage commences, and as the cells of all green plants contain substances known as enzymes, which act during the life of the cell, and continue to act even after the death of the plant cell, it was anticipated

*Quoted by Dr. E. J. Russell, *Journal Agricultural Science*, July, 1908 (2-4).

that the respiratory action of the plant cells and the enzymes would play an important part in the changes which took place. This proved to be so, and Dr. Russell visualised the process in the following words:—

> "When the cells (of the maize plant) are put in they are alive, and their vital functions continue. Respiration goes on and sugar, etc., is used up, but in the absence of air oxidation is not complete, and intermediate bodies, alcohol, acetic acid, butyric and other acids are formed in addition to carbon dioxide and water. The tryptic enzymes of the cell act on the protein forming the usual hydrolytic products, amino acids, diamino acids, etc.; from the nucleoproteins purin bases are produced in addition. The heat developed during these processes cannot be dissipated, as it usually is in the living plant by the evaporation of water, because water vapour cannot escape from the silo; instead it raises the temperature of the mass. Respiration is accelerated by the increased temperature, but, as no more material is being elaborated and only decomposition is taking place the process soon comes to an end; the cell then dies for want of more substance to break down, it loses its turgidity, and becomes flaccid, causing the mass to settle down. The temperature also steadily falls. The decomposition of the protein, which had also been accelerated by the rise in temperature, can continue even after the cell is dead, because the enzymes when once formed are not dependent on the life of the cell—in other words, it is an autolytic decomposition. Some of the products formed in the above changes inhibit the development of mould, and the general conditions obtaining in the silo are unfavourable to putrefaction. The mass therefore remains good for food for a long time."

It will be seen from the above that the primary and essential causes of the changes during ensilage are the respiratory action of the plant cells whilst living, and enzyme activity before and after their death, other subsidiary and non-essential changes may occur, and are due to bacterial activity. The changes are accompanied by considerable self-heating, which results in the loss of dry matter, principally carbo-hydrates, and also in the decomposition of portion of the true protein. The products which result from the decomposition of the protein are not lost, but cannot be utilised for the building and repair processes for which the true protein is alone suitable. The resulting nitrogenous compounds are, therefore, less valuable as food than the protein from which they are derived.

Sweet and sour silage.

The presence of organic acids consequent upon the changes which take place during ensilage gives the silage its characteristic taste and smell, and is the basis distinguishing between "sweet" and "sour" silage. All silage is sour, but all silage has not a pronounced acid smell. This is because the same acids are not present in all kinds of silage. *Woodman states that the principal acids present in silage are—

(a) Acetic acid (the acid of vinegar, possessing a sharp acidic smell).
(b) Propionic acid (similar in properties to acetic acid).
(c) Butyric acid (contained in rancid butter and possessing an offensive smell).
(d) Lactic acid (the acid of sour milk, possessing little or no smell, but having a sharp acidic taste).

(a), (b) and (c) are usually referred to as volatile acids, whilst lactic acid is termed a non-volatile acid. It is, therefore, possible to smell the former but not the latter.

*Woodman *Journal Ministry of Agriculture*, May, 1925.

When the total quantity of volatile acids is in excess of that of the non-volatile, the silage is known as "acid," because of the distinct acid smell which it then has. The presence of butyric acid imparts a distinctly offensive smell to silage; this is now regarded as an indication that the process has been defective in some respect, and in consequence the silage is partially spoilt. Woodman also states* that in properly made silage butyric acid should be entirely absent, and gives typical figures for the amounts of organic acids present in good maize silage, and which furnish proof of his contention. These are—

	Per cent. of moist silage.
Acetic acid	0.41
Propionic acid	0.04
Butyric acid	0.00
Lactic acid	0.89

Kinds of silage.

At one time all kinds of silage were broadly classified as either "sweet" or "acid," but because of the increased attention being given to the study of silage problems this rough classification proved inadequate, and in 1917 experiments designed to define the different types of silage which were capable of being produced were commenced by Messrs. Amos and Williams.† The experiments were also designed to define the conditions under which each type could be produced. The results of their experiments are set out in the following conclusions:—

1. Many different types of silage may be produced from the same crop according to the conditions of ensiling; the characteristics of the resulting silage varying not only in physical and chemical but also in feeding properties.

2. The following types of silage have been differentiated and some of the conditions of their production ascertained:—

(a) "Sweet" dark brown silage. This type of silage is produced when the temperature of fermentation rises above 45deg.-50deg. C. (113deg.-122 deg. F.); it has not been produced below 45deg. C. It is frequently produced in stack silage to which air has ready access, but not generally in tower silos except in a shallow layer 6in. to 2ft. thick just below the mouldy surface to which air has ready access. This silage has a dark brown colour, varying in intensity according to the temperature of fermentation, and a sweet pleasant smell resembling that of heated hay. It is readily eaten by stock, but has generally lost a considerable proportion of its food value through excessive heating.

(b) Acid light-brown or yellow-brown silage is produced in tower silos from crops which are moderately mature when cut and allowed to wilt for varying periods according to the initial dryness until the moisture content of the crop approximates 70 per cent. The maximum temperature of fermentation is generally between 30deg. and 37deg. C. (86deg.-99deg. F.). This silage has a yellowish-brown to brown colour with an acid though pleasant smell probably largely due to acetic acid, the yellowish types being generally the more pleasant. This type of silage is eaten greedily by stock, which thrive upon it, and is to be commended.

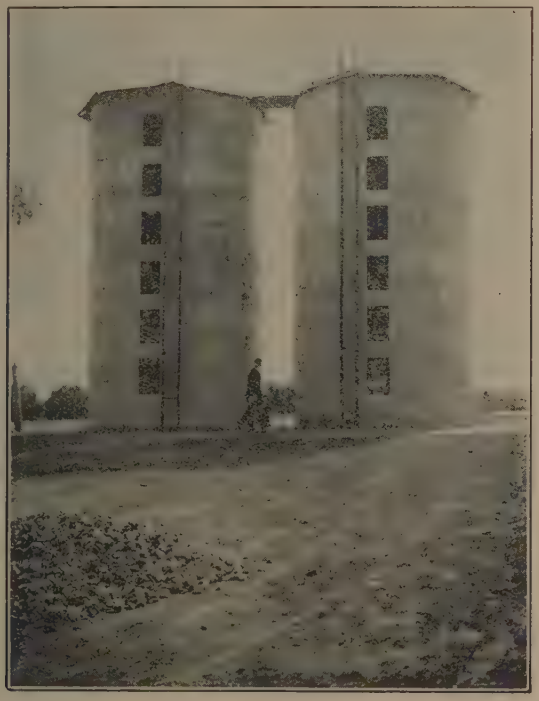
(c) Green "fruity" silage is produced in tower silos from crops which are cut in the earlier stages of maturity from the time of full flower till the seeds are half formed. The crop must also be ensiled soon after cutting. The temperature of fermentation is low and may vary from 22deg. C. to 34deg. C. (71.6deg.-93deg. F.). This type has a green to olive-green colour with a smell that is neither "sweet" nor "sour," but can best be described as "fresh" and "fruity." It is greedily eaten by stock, which thrive greatly upon it, and Woodman has recently shown that its digestible properties are very high. Green silage suffers from one practical disadvantage: large quantities of juice are liable to drain away from the silage and carry with

*Woodman, *Journal Ministry of Agriculture*, May, 1925 (32-2).
†*Journal Agric. Science*, Oct., 1922 (12-4).

them soluble food material, which, if allowed to accumulate in the yard, undergoes fermentation and produces a smelly mass of putrid material. If, however, the juice is collected, cattle and pigs readily drink it.

(d) Sour silage is produced under at least two different sets of conditions. It may be produced from an immature and succulent crop, or it may be produced from a crop which has been cut and then saturated by rain before ensiling, especially when the crop has become laid and partially rotten at the base before cutting. Sour silage has a dark brown or olive-brown colour with a pungent and most unpleasant smell, possibly due to butyric acid. Cattle will eat this, but not readily, and do not generally thrive upon it.

(e) Musty silage. One case only of this type had been recorded, in which an over-ripe crop containing much charlock was allowed to wilt and become over-dry before ensiling. A number of tiny mouldy centres were produced in which ammonia was generated. This silage has a dark-brown, almost black, colour, and has a musty ammoniacal smell. Stock refused to eat it, or ate it only under compulsion.



Twin concrete "tower" silos at Cuttening.

The results of these investigations show that the condition of the crop and the moisture it contains—natural or added—influences the quality of the silage. The worst type—"Musty"—is that made from over-ripe and over-dry material, whilst another only slightly inferior to it is made from immature or excessively wet crops. Both these extremes are to be avoided, and crops should be utilised at a stage of maturity when they are still succulent, but not so succulent that their juices will be pressed from them to drain away on being packed in the silo or pressed in the stack. In selecting the stage at which to cut the crop for silage it is, however, better to err, if at all, on the side of succulence than on that of extreme dryness.

The one drawback associated with the production of the best type—"green fruity" silage—is the loss of the plant food which drains away in the juices which are pressed from it. Because of this juice drainage, which invariably results from the making of the best silage, *i.e.*, "fruity" silage from cereals in tower silos, it is recommended that, in order to prevent the waste of soluble food material, five or six feet at the base of such silos be embedded in the ground, or alternatively, that the same depth at the bottom be filled with dry material, like straw or cereal hay, in order to absorb the liquid which finds its way to the lower strata. This plan has been adopted in connection with the silo at the Mecke.ing Research Station.

As "green fruity" and "acid light-brown" are the best kinds of silage, and are produced with relatively low temperatures, it is advisable to adopt such steps as are possible to exclude the air and keep down the temperature. In the case of chaffed material these would include cutting the fodder into short lengths, quick filling and good packing; in the case of long unchaffed material of quick filling and pressure. Such measures will also tend to prevent overheating and burning, which takes place when the temperature necessary for the production of "sweet" silage is passed. Such additional heating is associated with the unnecessary destruction of dry matter and consequent loss of food material.

Losses of nutrients during silage production.

It is obvious that the self-heating which occurs during ensilage is due to the oxidation of the "dry matter" in the crop. For a long time it was believed that this loss of nutrients must be very considerable even when the heat generated did not exceed that necessary for "sweet" silage. Messrs. Woodman and Amos,* however, in a recent report, show that on theoretical grounds this is not so. They point out that with the green forage containing 30 per cent. of dry matter, and starting with an initial temperature of 20deg. C. (68deg. F.) the temperature could be raised to 51deg. C. (123.8deg. F.)—a temperature at which the plant cells cease to respire, and high enough for the production of "sweet" silage—at a cost of only 2 per cent. of the dry matter. It was further shown that this theoretical finding was not discordant with the actual results as found in their investigations, and which showed that good "sweet" silage could be produced without undue loss of dry matter, and that large losses of dry matter were not necessarily due to high temperatures. These results are—

How made.	Character of silage.	Temperature attained. F.	Loss of dry matter. %
Tower or Tub Silo ..	Sweet.	117.7	.71
	do.	127.8	4.51
Stack Silo	do.	152.1	4.70
	do.	170.9	9.40
Clamp or Trench ..	Sour.	99.5	25.60

In summing up these writers state—

1. . . . . The amount of destruction of carbohydrate bears no significant relation to the temperature attained during preservation, and the factors of (a) juice drainage, (b) bacterial decomposition of carbohydrate, (c) partial spoiling by undesirable bacterial activity, as with "sour" silage, are of much greater significance in causing unduly large losses of carbohydrate.

2. The results obtained in investigations with crops containing from 26.5 to 33.9 per cent. of dry matter show that "acid brown" silage can be made in the tower silo with an *average* loss of dry matter equal to 5-6 per cent. of that contained in the green crop. It is further concluded that "sweet" silage, if made under good conditions, can

Journal Agricultural Science, October, 1926 (16-4).

also be produced in the tower silo with an *average* dry matter loss of the same order. With "green fruity" silage, the *average* loss under proper conditions of ensilage in tower silos is of the order of 8-9 per cent. The evidence affords strong disproof of the statement that the ensilage of green crops cannot be accomplished without large losses of nutrient matter.

3. Evidence is brought forward in support of the statement that when a silo is filled with crops of fairly uniform moisture content, the lowest losses of dry matter occur in the middle layers of the column of silage.

4. The losses during ensilage may be excessive when the silo is filled with very sappy or rain-laden crops, or when a mass of wet material is super-imposed on a crop which has been ensiled at a suitable moisture content. For the purpose of making silage of good quality, and at the same time keeping down the losses to a minimum, the optimum dry matter content of the green crop appears to lie in the region of 26-34 per cent. When the crop at the time of cutting is wetter than is represented by the lower of these figures, it is desirable to allow a period of wilting, if weather permits, to enable the crop to attain a moisture content in the neighbourhood of 70 per cent. A preservation period of about a fortnight appears to be quite long enough for a green crop to acquire the essential characters of silage.

Here is further evidence that the crop should not be too sappy, nor too wet when being made into silage. Provided care is taken in this connection the losses of dry matter need not be excessive, and it is claimed by Woodman† that they need not exceed those which occur during the conversion of a green crop into hay. Such remarks apply to the conditions under which hay and silage may be made in Great Britain where the conditions for hay making are not nearly as good as those which obtain in the agricultural belt of of Western Australia. The bleaching which takes place on the outside of the sheaves indicates that chemical changes have taken place, but here the conditions are invariably so good, and so nearly ideal that the loss of nutrients during hay making must be very slight.

The conditions under which silage crops will be cut will also be more uniform so that it is possible that the losses of properly made silage from crops cut at the proper stage of maturity may be reduced. To show the losses which occur in the two best kinds of silage as made at the University Farm, Cambridge, the writer already referred to, supplies the following information:—

GAINS OR LOSSES IN SILAGE PRODUCTION.

	Green fruity silage. Percentage gain or loss.	Acid brown silage. Percentage gain or loss.
Dry matter	—11.2	— 7.7
Crude Protein (including amides) ..	— 8.2	0.0
Crude Oil (mainly organic acids) ..	+52.4	+45.0
Carbohydrate	—19.1	—14.7
Fibre	— 5.5	— 6.0
Ash (inorganic salts)	— 9.2	0.0
True (crude protein minus amides) ..	—41.0	—28.4
Amides (mainly digestion products of true protein)	+85.3	+96.0

†*Journal Ministry of Agriculture*, May, 1925 (32-2).

The latest recorded work in this connection is that of Watson and Ferguson reported in the *Journal of Agricultural Science*, Vol. 26, page 337, July, 1936. These authors state (page 363) that in good silage the non-protein nitrogen is of high value, and that the digestible crude protein is a better measure of the value of the protein than the digestible "true" protein which hitherto has been usually accepted. This means that the amides (mainly digestion products of true protein) may be given an equal value with the true protein in assessing the nutritive ratio of good silage.

Though these figures show that when silage is made under reasonably good conditions the loss of dry matter is not very great, they do show a very considerable loss of true protein. As already explained this loss in both cases is due to the breaking down of the protein by enzymes, but in the case of the "green fruity" silage the normal loss in this connection is increased, as is also the loss of inorganic salts by drainage of juice away from the silo. Even under good conditions considerable losses of protein in the silo are unavoidable, and as such do not occur in well made hay, it follows that—unless there are very special reasons for doing otherwise—leguminous crops as lucerne, clover, peas, etc., which are specially rich in protein, and which are usually grown to supply farm protein deficiencies, should be made into hay rather than into silage.

Though the loss of dry matter was greater during the transformation of the crop to "green fruity" silage rather than during the transformation of the same crop to "acid brown" silage, it is pointed out that "green fruity" silage is distinctly superior to the "acid brown" type in regard to palatability, and further it had a very pleasant aroma due to the production by fermentative activity of small quantities of fragrant smelling substances.

Digestibility changes due to silage production.

In addition to knowing what loss of nutrients occurs during ensilage, it is also important to know what beneficial, or other effect, the process has upon the digestibility of the nutrients in the green crop from which the silage is made. In this connection some illuminating information* is obtained from the results of an experiment conducted at the University Farm, Cambridge, when determinations were made of the digestibility of green oats and tares, and also of hay and silage made from the same crop, and under conditions which made it possible to secure a fair comparison of the feeding values of the three types of fodder. The results are given in the table hereunder, and are in terms of digestion co-efficients. It may be stated that the digestion co-efficient of a given food constituent represents the number of parts of that constituent which are digested per each one hundred parts consumed:

DIGESTION CO-EFFICIENTS OF GREEN FODDER HAY AND SILAGE FROM THE OAT AND TARE CROP.

	Green oats and tares.	Oat and tare hay.	Oat and tare silage.
	%	%	%
Dry matter	63.7	65.0	64.1
Protein	63.1	68.2	65.1
Crude Oil	51.9	36.8	73.4
Carbohydrate	76.5	71.3	70.5
Fibre	47.6	58.7	57.1

From the above data the following conclusions were drawn:—

(1) The digestibility of the dry matter is of the same order in all three cases.

(2) There is no serious difference in the degree to which the protein of the three fodders is digested.

(3) The digestibility of the oil fraction is greatest in the case of the silage, though it must be remembered that the ether extract of silage is composed almost wholly of organic acids.

*Woodman, *Journal Ministry of Agriculture*, May, 1925 (32-2).

(4) The carbohydrates of the hay and silage are approximately of equal digestibility, and in both cases the digestibility is somewhat lower (but not to such an extent as was thought formerly) than that of the corresponding fraction of the green forage.

(5) The fibre constituents of the hay and silage are almost equally digested, but the fibre of the fresh green crop possesses an appreciably lower digestibility. This finding confirms the supposition that heating in the stack and in the silo leads to a definite increase in fibre digestibility. In view of the fact that such fodders contain large amounts of fibre this increase of digestibility becomes of considerable significance.

*Hot and cold fermentation systems for making silage.**

The many methods followed by farmers in making silage can be grouped under two different systems, namely, what are known as—

(a) the cold fermentation system, and
(b) the warm fermentation system.

Under the system of **cold** fermentation the freshly cut green fodder is placed in the pit or silo, and is packed by tramping as quickly and as firmly as possible, so as to drive out, without delay, the maximum quantity of air from between the stems and leaves. The oxygen of the small quantity of air which then remains is absorbed by the plants themselves by respiration (breathing) and without any great rise in the temperature of the mass. Usually the rise in temperature does not exceed 10deg. F. After a short period of intra-molecular respiration the plants die by suffocation; during this period small quantities of organic acid are developed by incomplete oxidisation. After this, as the result of the development of certain lactic acid bacteria, especially *Bacterium cucumeri fermentati* and *Bacterium lactis acidi*, a part of the soluble carbohydrates is transformed chiefly into lactic and other organic acids. When the concentration of acid reaches about two per cent. of the total volume of the silage, fermentation stops and the green fodder is then preserved as the result of the acid formed. The silage so made is the "green fruity."

When it is intended to use the **warm** fermentation process of making silage, it is necessary that the green crop be allowed to wilt after cutting, until the water contents are reduced to between 65 and 70 per cent. The silo or pit is then filled slowly, and without packing, at the rate of from three to six feet each 24 hours. Under such conditions there is an abundance of air amongst the greenstuff, and this is used by the plants for intensive respiration, and, in consequence, the result is a great rise in temperature. When the temperature rises to over 120deg. F. the mass of silage is firmly packed by tramping, or by the application of pressure by other means.

The high temperature of the silage resulting from rapid respiration of the plants, and the work of the thermophilic (heat loving) bacteria causes the death, by heat, of the green plants and of many heat sensitive micro-organisms. Those which are killed do not, however, include the so-called warm lactic acid bacteria, *e.g., Bacterium kolbrucki, Bacterium bulgaris*, and certain *Streptococcus spp.* The optimum temperatures at which these bacteria flourish lie between 105deg. and 120deg. Fah., and they are able to live in the absence of air, that is, they are anaerobic. The pressure applied to the material in the silo drives out the air, and this condition, combined with the temperature prevailing (not exceeding 120deg. Fah.) provides favourable conditions for the warm lactic acid bacteria to develop.

*Silage Making by the Hot and Cold Processes, H. Krause., Dr. Phil. Nat., Jour. of Agric., W.A., Sept., 1933, page 327, et seq.

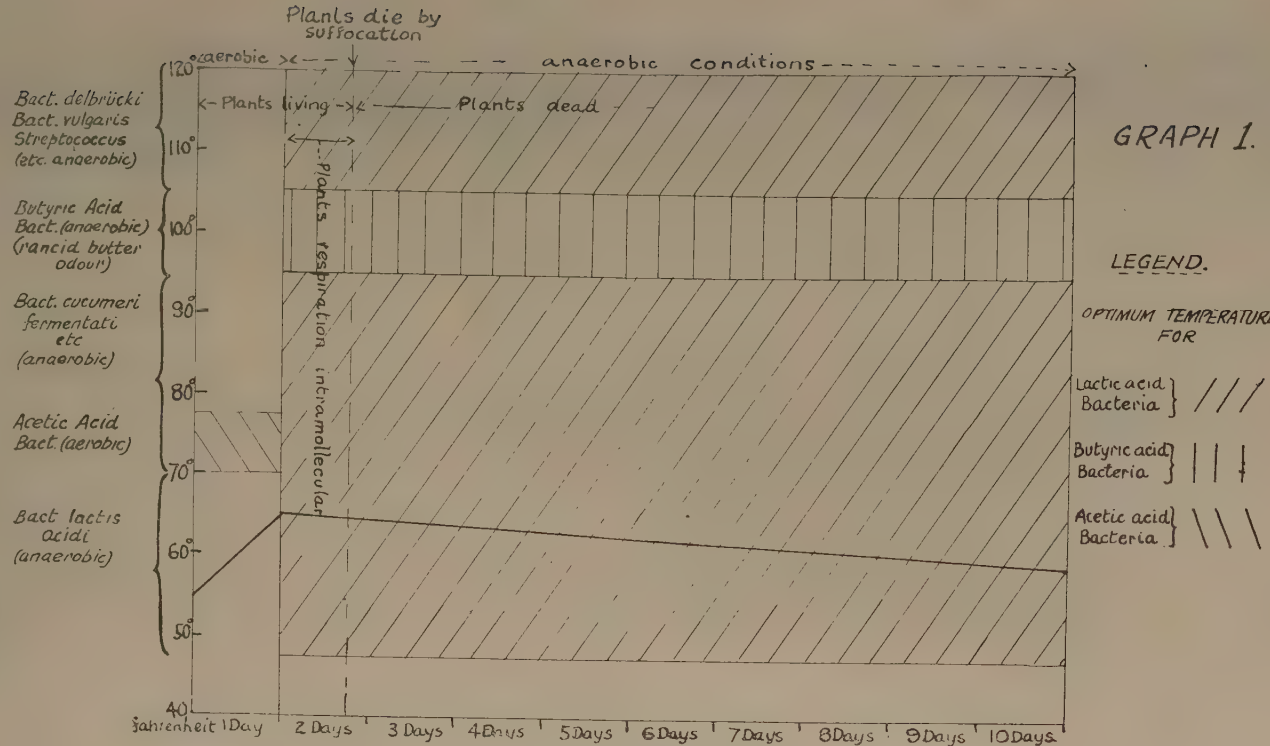
As the result of the pressure being applied the air is driven out, the temperature ceases to rise and slowly declines. The slow fall in temperature is important, for it is very desirable that, as the result of the activities of the warm lactic acid bacteria, the acid contents of the silage mass should have reached from one to one and a-half per cent. by the time the temperature falls to 105deg. Fah. This degree of acidity stops the fermentation and the silage is conserved. Unless acid is developed to this extent before the temperature falls below 105deg. Fah., the butyric acid bacteria become active under the anaerobic (without-air) conditions and produce a foul-smelling silage with the odour of rancid butter, and of decreased feeding value. The butyric acid bacteria flourish at temperatures ranging between 95deg. to 105deg. Fah., and can even form spores at higher temperatures. "Sweet" silage is made by the warm fermentation process.

By the adoption of the cold fermentation method it is easy, provided it is properly done, to keep the temperature *under* the optimum temperature for the growth of the butyric acid bacteria. The risk of forming butyric acid in the silage is, therefore, very much greater when the warm fermentation method is used than when the cold one is adopted. Under the warm fermentation method the only chance of preventing the formation of butyric acid is for the temperature to be kept between 105deg. and 120deg. Fah. for sufficiently long to allow for the development of about one and a-half per cent. of lactic acid, and so stop the fermentation. Obviously, to control the temperature until the proper degree of acidity is reached is not easy, and very often will be impossible.

The less desirable development of acetic acid bacteria, which are aerobic, *i.e.*, need air for their development, is also very easily prevented by the adoption of the cold fermentation method with the exclusion of air. It is comparatively easy to create anaerobic (without air) conditions as the result of tramping the green material as firmly as possible immediately it is placed in the silo or pit; this thorough packing drives out the air in the mass of green material and excludes the entry of fresh supplies.

The two graphs herewith illustrate the changes that take place under the two methods. On the horizontal line the number of days (one to nine) from the commencement of the process are shown. On the vertical line the temperatures reached are shown. The optimum temperatures of some of the types of bacteria referred to are also given: the optimum temperatures for the lactic acid bacteria are shown thus / / / / ; those of the butyric acid bacteria thus | | | |, and those of the acetic acid bacteria thus \ \ \ \ \.

Graph No. 1 shows the changes resulting from the cold fermentation method. The temperature of the crop on going into the silo was 55deg. Fah. As the result of the firm packing at the time and the respiration of the plants, a rise in the temperature was found to occur only during the first day. After the end of this day the temperature had risen to 65deg. Fah., that is, lower than the optimum temperature of the acetic acid bacteria, which is from 70deg. to 80deg. Fah. During the second day the remainder of the oxygen in the air was used up, and the establishment of anaerobic conditions were completed. This prevented the further formation of acetic acid, as the bacteria responsible for this cannot develop under anaerobic conditions. After a short period of intra-molecular respiration the plant cells died of suffocation. Following this the temperature fell very slowly, and remained for a period of at least eight days within the optimum temperature of the cold lactic acid bacteria. It will be noticed that the optimum temperature for the anaerobic butyric acid bacteria was not reached during the process and hence the unpleasant smell caused by these bacteria was not generated.



The Cold Fermentation System.

Graph No. 2 represents the results of the warm fermentation method. The temperature at which this material was taken to the silo was 70deg. Fah. This was as the result of the partial drying which the material received in the paddock after being cut and prior to being placed in the silo. Because of the loose packing at the outset the respiration of the plants was intense, and, as the result of this, the temperature rose quickly, reaching 120deg. Fah. by the second day, and the plants were killed by the heat. The material in the silo was then packed and as much of the air forced out as possible; the conditions became largely anaerobic. Under these anaerobic conditions, and with a temperature between 105deg. and 120deg. Fah. the warm lactic acid bacteria developed and formed lactic acid. During this process the temperature decreased slowly, and on the ninth day reached, as shown on the graph, the optimum temperature of the butyric acid bacteria. As already pointed out, it is important that prior to this the lactic acid contents should have reached one to one and a-half per cent., otherwise the butyric acid bacteria would develop butyric acid and more or less decrease the value of the silage.

In practice the cold fermentation method provides a much better opportunity and a safer means of producing good silage and by it the best two types—"green fruity" and "acid brown"—are made.

Material suitable for silage making.

Good silage has been made from many plants including variegated thistles, crowfoot or geranium, and native grasses, as well as from the cultivated crops. Almost any green plants can be made into silage provided care is taken to see that they are harvested at the proper stage of maturity, or after cutting wilted or dried to ensure that their succulence is within the latitude found necessary for the making of good silage, viz., that the percentage of moisture shall range between 66 per cent. and 74 per cent.

On farms silage will be made invariably from cultivated crops, and the crops utilised will be those which can be grown with the greatest ease and most certainty in that particular district. Where maize (or "Indian corn") can be grown readily it is a favourite silage crop, and is admirably suited for the purpose, because of its high-yielding capabalities and solid stalks. Sorghum and Sudan grass are also excellent, and more suitable for districts where the summer rainfall is not liberal enough for reliable and heavy maize crops.

The winter cereals, wheat, oats, rye and barley make good silage, though at one time they were considered unsuitable because their stems were hollow, and therefore were air filled, and it was anticipated that it would be difficult to control the temperature sufficiently during ensilage to prevent undue waste. This fear has proved to be unfounded. Excellent silage has been made from cereals either alone or mixed with peas or other legumes throughout Australia.

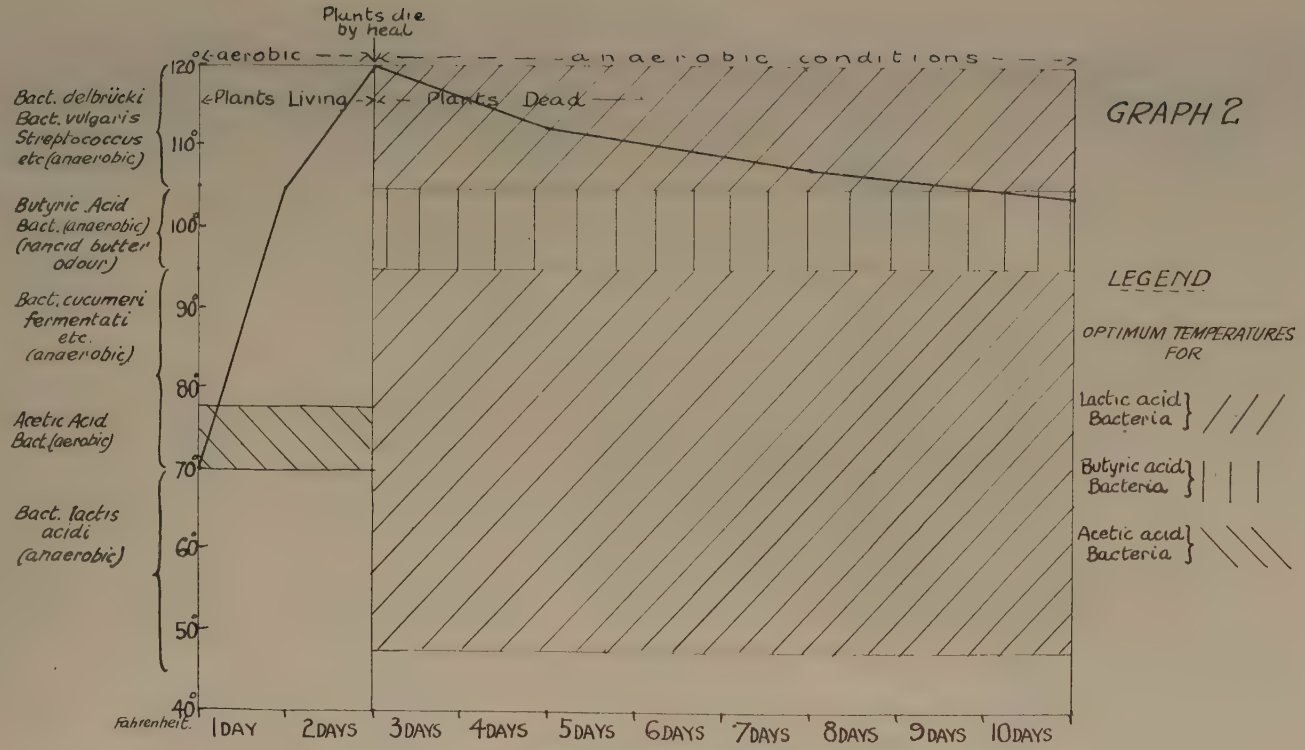
Sound silage making methods.

From what has been learnt about the changes which take place during ensilage, and the causes of them, it is obvious that the two essentials for making good silage are—

(1) that the crop shall not be ripe, and contain not more than 74 per cent. of moisture, nor less than 66 per cent.;

(2) the temperature during ensilage shall not rise much above 122deg. F. and kept if possible below 90deg.

The first essential is determined by, and under the control of the farmer before the commencement of the transformation from green fodder to silage. The second essential is governed by the exclusion of air during ensilage. It therefore follows that the fundamental principle underlying the transformation from fodder to silage is the *exclusion of air.*



The Warm Fermentation System.

Farmers cannot be expected to determine the moisture content of their silage crops by analytical methods, nor is there any need that they should. The maturity of the crop is a very good guide as to the amount of moisture it contains, and with the latitude of from 66 per cent. to 74 per cent. this may be accepted as a satisfactory guide for silage-making purposes. Thus with the cereals the period of full flower is the proper time to cut them, and with the maize (or "Indian corn") when the kernels are dented and well on towards maturity. Experience with the general appearance and condition of these crops at the proper stage of maturity will indicate to the farmer the proper stage at which to harvest other crops for the same purpose. Cereals are to be cut when in bloom, preferably in early bloom.

After cutting the crop at the right stage, if air be excluded, the fodder will change to silage and be preserved; if air gain access during ensilage wastage is inevitable, and the more readily the air can gain access the greater will be the waste.

Seeing that high temperatures are not essential to the production of the best kinds of silage, and further, "as an unnecessarily high temperature implies undue destruction of carbohydrates, and may cause an appreciable depression of the digestibility of the protein constituents,"* there is every inducement to keep the temperatures as low as possible. This is effected by the *exclusion of air* as affected by skilful chaffing, early packing and pressure.

Summed up, the essentials for making good silage are:—

1. To have the right kind of green feed, *e.g.*, cereals or mixed pasture.
2. To cut it at the right age, *e.g.*, oats whilst flowering.
3. To cut it evenly and well with a silage cutter or chaff cutter, so that it will pack readily.
4. To pack it as quickly and as firmly as possible in silos or in pits so as to drive out and exclude the air.
5. To prevent further access of air to the material in the silo. To achieve this it is necessary, if earthen pits are used, to cover the silage quickly and make it air-proof, not only on the top, but also on the sides. As the silage in a pit silo packs itself more closely together it is also necessary, especially in the first weeks, to fill up the openings or cracks which appear in an earth covering on the top; this should be done every day if necessary.

With reasonable care useful silage is almost sure to be the result. At the first attempt, or under new conditions, the silage produced may not be just the kind desired, but its condition will indicate how improvements are to be effected, and the methods likely to be most satisfactory under the conditions which obtain on any particular farm.

The causes of, and remedies for, some of the defective kinds of silage are indicated hereunder:—

Unless found on the external surfaces, silage which is not distinctly moist, and is inclined to be dry with a tendency to be mouldy, indicates that the fodder from which it was made was too dry, either from over-maturity, or from wilting, and should have had water distributed over it. When such silage is found on external surfaces its condition is due to its location, and is caused by the admission of excessive, and probably unlimited, quantities of air.

At one time it was thought that juice drainage indicated that the crop when cut for silage was either immature or contained too much water from external sources, probably from rain. During recent years it has been found,

*Woodman, *Journal Ministry of Agriculture*, May, 1925 (32-2).

that this is not always the case with cereal silage in Western Australia. Juice invariably drains away from "tower" silos when filled with and packed properly with cereal fodder cut at the right stage of maturity, *i.e.*, when in bloom.

Extremely dark coloured silage indicates that the temperature has been too high, due to excessive oxidation consequent upon the inclusion of or admission of too much air. This calls for more expedition with the work, and the exclusion of air either by packing or pressure.

An offensive smell is due to the production of butyric acid and it is best prevented by keeping the temperature of the fodder low (*i.e.*, below 95deg. F) during ensilage by thorough and rapid packing and pressing.

The rape plant, and other members of the cabbage family (*Brassicae*) are regarded as unsuitable for silage making, not only on account of their excessive succulence, but also because the silage made from them develops a most objectionable odour.

Though good silage can be made from lucerne, peas, clovers, and other leguminous crops, as already stated, it is considered preferable to make them into hay on account of the greater protein losses when preserved as silage than when made into hay unless the silage is made by the cold process and the temperature prevented from rising above 90deg. F.

How silage can be made.

Silage can be made in stacks or in silos constructed below the surface of the ground, or erected above it. The underground silos are known as "pit" silos, and a "trench" silo is a special form of "pit" silo. Above ground silos, because of their appearance, are called "tower" silos, and these, if round and made of wood, are sometimes referred to as "tub" silos. The simplest form of wooden silo is constructed of a single layer of planks placed vertically edge to edge with their ends on the ground and held together by means of iron bands, just as the staves of a cask are held together by means of the hoops; silos of this type are known in America as "stave" silos.

Tower Silos.

The modern silo is undoubtedly the "tower" silo. It can be made of almost any material which is wind and rain proof, and which is also strong enough, or can be supported so as to be strong enough to resist the pressure exerted by the material with which it is filled. They have been constructed of wood, iron sheeting, asbestos sheeting, brick, stone and reinforced concrete, the last-named holding pride of place in Western Australia. It is admirably suited for silo construction because of its strength, smoothness, and durability.

Recent experience in Western Australia has shown that the silo acids attack the material in concrete walls and so damage the latter. To protect these it is desirable to paint them with one of the bituminous compounds now on the market.

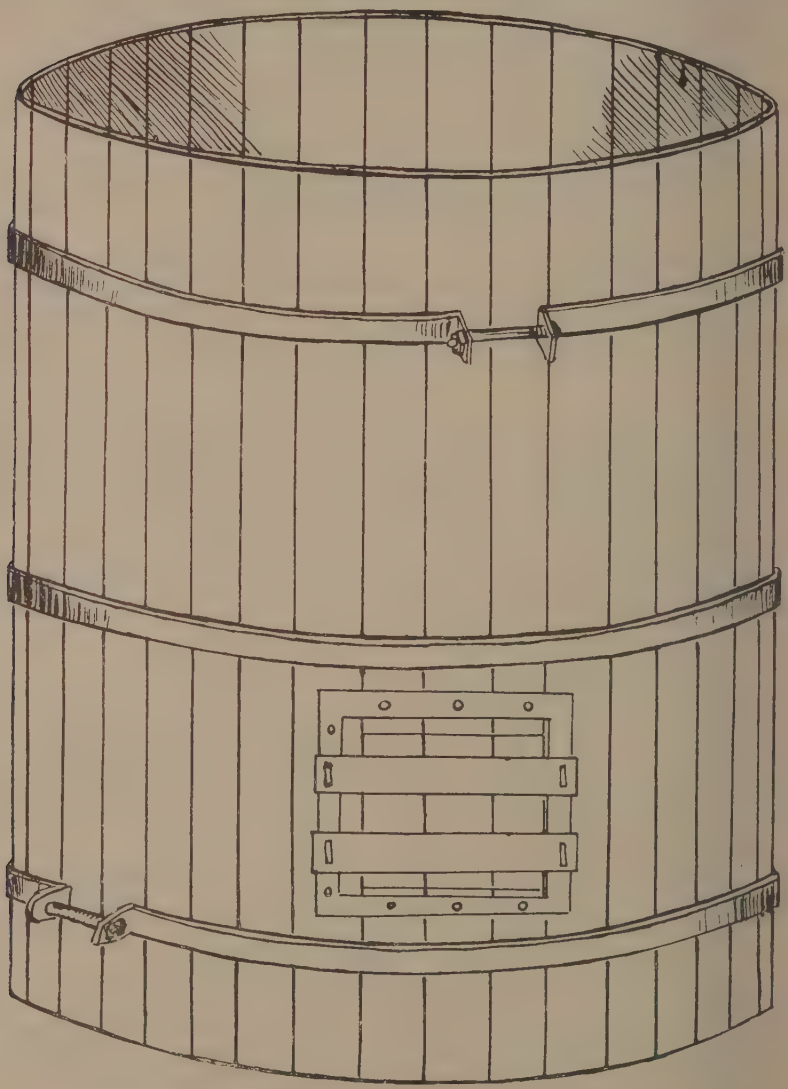
The first silos were rectangular, but difficulties arose in connection with packing the material in the corners sufficiently well to prevent decay; even when the corners were partitioned off settlement was hindered, and waste still occurred.

To overcome these difficulties, "tower" silos are usually circular in shape, or, if the material—*e.g.*, asbestos sheets—does not lend itself to this shape, they are made many-sided—12 or 16—so as to have very obtuse angles, and thus little resistance to settlement, and consequent exclusion of air.

The walls of the silo must be rigid and strong for as King* points out, "The outward pressure of cut corn (maize) silage when settling, at the time of filling, increases with the depth at the rate of 11 lbs. per square foot for each foot of

* "Physics of Agriculture."

depth. At a depth of 10 feet the lateral pressure is 110 lbs. per square foot, at 20 feet it is 220 lbs., and at 30 feet 330 lbs."; and further, "Because of the great pressure silo walls must be made very strong when they have a depth of 20 or more feet. It is difficult to make deep rectangular silos whose walls will not spread, as



The simplest form of "stave" silo.

represented in the diagram herewith, and where this takes place the walls are crowded away from the silage so much that air can circulate up and down next to the walls, and this results in heavy losses."

The walls of the silo must also be smooth so as to offer little resistance to the settlement of the fodder during ensilage. Unless settlement takes place uniformly air is not thoroughly excluded, with the inevitable loss either by decay or the production of inferior silage.

Silo walls must be rigid (after King).
If the pressure whilst filling causes the walls to bulge air is admitted, and wastage results.

King* supplies the following information regarding the quantity of silage in round silos of different diameters:—

TABLE GIVING THE APPROXIMATE CAPACITY OF CYLINDRICAL SILOS FOR WELL-MATURED CORN SILAGE, IN TONS (King).

"B."

Depth in feet.	Inside diameter in feet.											
	15	16	17	18	19	20	21	22	23	24	25	26
20 ...	58·84	66·95	75·58	84·74	94·41	104·6	115·5	126·6	138·3	150·6	163·4	176·8
21 ...	62·90	71·56	80·79	90·57	100·9	111·8	123·3	135·3	147·9	161·0	174·7	189·0
22 ...	67·35	76·52	86·38	96·84	107·9	119·6	131·8	144·7	158·1	172·2	186·8	202·1
23 ...	71·73	81·61	92·14	103·3	115·1	127·5	140·6	154·3	168·7	183·6	199·3	215·5
24 ...	76·12	86·61	97·78	109·6	122·1	135·3	149·2	163·7	179·0	194·9	211·5	228·7
25 ...	80·62	89·64	103·6	116·1	129·3	143·3	158·0	173·4	189·5	206·4	223·9	242·2
26 ...	85·45	97·23	109·8	123·0	137·1	151·9	167·5	183·8	200·9	218·8	237·4	256·7
27 ...	90·17	102·6	115·8	129·8	144·7	160·3	176·7	194·0	212·0	230·8	250·5	270·9
28 ...	94·99	108·1	122·0	136·8	152·4	168·9	186·2	204·3	223·3	243·2	263·9	285·4
29 ...	99·92	113·7	128·3	143·9	160·3	177·6	195·8	214·9	234·9	255·8	277·6	300·2
30 ...	105·0	119·4	134·8	151·1	168·4	186·6	205·7	225·8	246·8	268·7	291·6	315·3
31 ...	109·8	124·9	141·1	158·2	176·2	195·2	215·3	236·3	258·2	281·8	305·1	330·0
32 ...	115·1	135·9	147·8	165·7	184·6	204·6	225·5	247·5	270·5	294·6	319·6	345·7

*"Physics of Agriculture."

From the above figures it will be seen that the capacity of a silo is increased at a greater rate than the square of their respective diameters. This is because in the larger silos the friction is less and the silage becomes more compact. Thus doubling the diameter increases the capacity more than fourfold, and therefore silos of large diameter are more economical than small ones. Despite this, however, the diameter of a silo must be *governed by the number of animals to be fed.*

Diameter of the silo.

Silage is fed out of a silo by removing the surface layer daily. It has been found that the rate of removal should not be less than about 1¼ inches, and is preferably greater, say, two inches. The table on page 26 will serve as a guide to indicate the maximum inside diameters of silos to meet the requirements of specified numbers of cows, when each cow is allowed between 35 and 40 lbs. of silage per day.

THE DIAMETER OF CIRCULAR SILOS IN RELATION TO THE NUMBER OF COWS FED.

No. of Cows.	Maximum diameter of silo when mean quantity of silage removed daily from surface is—		No. of Cows.	Maximum diameter of silo when mean quantity of silage removed daily from surface is—	
	2 inches. feet.	3 inches. feet.		2 inches. feet.	3 inches. feet.
10	8·0	6·5	30	13·8	11·3
12	8·7	7·1	32	14·3	11·7
14	9·4	7·7	34	14·7	12·0
16	10·1	8·3	36	15·1	12·3
18	10·7	8·7	40	16·0	13·1
20	11·3	9·2	44	16·7	13·7
22	11·8	9·6	48	17·5	14·3
24	12·4	10·1	52	18·2	14·9
26	12·9	10·6	56	18·9	15·5
28	13·4	10·9	60	19·5	16·0

The depth of the silo is determined by the period during which it is intended to feed silage.

Deep silos are preferable to shallow ones, for the capacities of "tower" silos are not in direct proportion to their relative heights. The capacity increases at a greater rate because with the greater depth the material is compressed, and in consequence greater storage capacity is secured. Thus, with silos respectively 12 and 36 feet high, the storage capacity of the latter is five times that of the former, though the respective heights are only as three to one. The following table prepared by King* gives the weight of silage at different depths in "tower" silage.

Height 12
Volume 1
Capacity
1

Height 36
Volume 3
Capacity
more than
5

DEEP SILOS ARE MORE ECONOMICAL THAN SHALLOW ONES.

* "Physics of Agriculture."

TABLE SHOWING THE COMPUTED WEIGHT OF WELL-MATURED CORN SILAGE AT DIFFERENT DISTANCES BELOW THE SURFACE, AND THE COMPUTED MEAN WEIGHT FOR SILOS OF DIFFERENT DEPTHS, TWO DAYS AFTER FILLING.

Depth of Silage.	Weight of silage at different depths.	Mean weight of silage per cub. ft.	Depth of silage.	Weight of silage at different depths.	Mean weight of silage per cub. ft.	Depth of silage.	Weight of silage at different depths.	Mean weight of silage per cub. ft.
Feet.	lbs.	lbs.	feet.	lbs.	lbs.	feet.	lbs.	lbs.
1 ...	18·7	18·7	13	37·3	28·3	25	51·7	36·5
2 ...	20·4	19·6	14	38·7	29·1	26	52·7	37·2
3 ...	22·1	20·6	15	40·0	29·8	27	53·6	37·8
4 ...	23·7	21·2	16	41·3	30·5	28	54·6	38·4
5 ...	25·4	22·1	17	42·6	31·2	29	55·5	39·0
6 ...	27·0	22·9	18	43·8	31·9	30	56·4	39·6
7 ...	28·5	23·8	19	45·0	32·6	31	57·2	40·1
8 ...	30·1	24·5	20	46·2	33·3	32	58·0	40·7
9 ...	31·6	25·3	21	47·4	33·9	33	58·8	41·2
10 ...	33·1	26·1	22	48·5	34·6	34	59·6	41·8
11 ...	34·5	26·8	23	49·6	35·3	35	60·3	42·3
12 ...	36·9	27·6	24	50·6	35·9	36	61·0	42·8

Continuous doorways advisable in tower silos.

As the silo is emptied by removing successive layers from the surface and shovelling the silage through the openings or doorways in the wall, it is advisable that these should be as nearly continuous as it is possible to get them. This will obviate the unnecessary lifting of heavy material. For another reason it is also necessary that the distance between the top of the material in the silo and the bottom of the opening should never be greater than the height of the mouth of the person in the silo. This is necessary because when the silo is being filled carbon-dioxide—a poisonous gas—is generated, and during a still night may accumulate in the enclosed space of a partially filled silo, with possibly disastrous results to the person just entering same. The continued filling of the silo soon displaces this gas, and the danger, even under such conditions as referred to, exists only for a short period, but obviously it is to be avoided.

With reinforced concrete as the building material there is, of course, no difficulty in building circular silos, and complying with all the essential conditions which require that the silo shall be round and deep, with rigid smooth walls, and with an almost continuous doorway. The results of the Northam silage competition have shown that the very best silage can be made in these structures. That of the winner last year, Mr. W. G. Burges, "Tipperary," Burges Siding, was definitely ideal. It was olive coloured, "fruity" and good right up to the edge. It was made by the "cold fermentation" process. The three essentials by which Mr. Burges makes such ideal silage are—

(1) Cut the crop at the right time, that is, in early bloom;

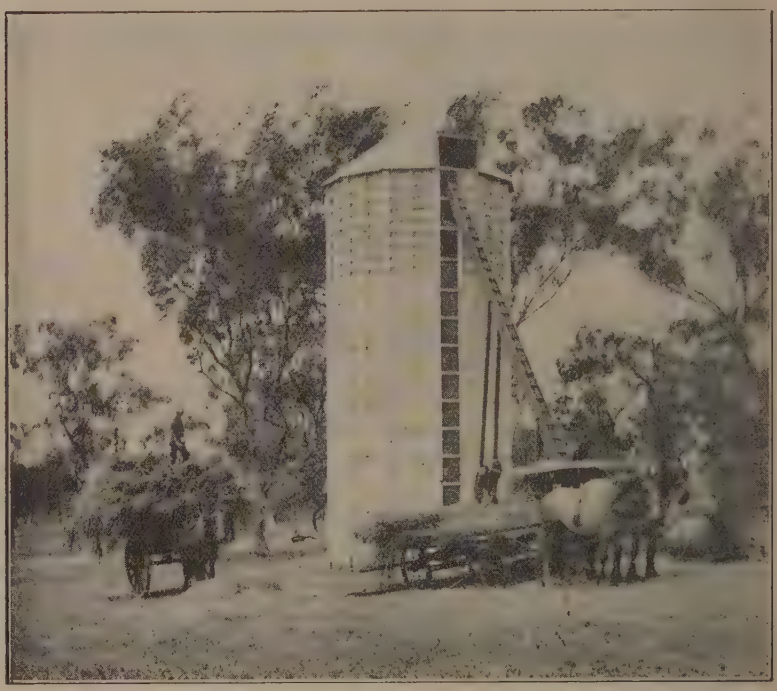
(2) Cut it evenly and thoroughly;

(3) Pack it quickly and thoroughly.

The exact stage at which the crop intended for silage will be harvested will depend to some extent upon the climatic conditions which obtain, or are likely to obtain at the time. If the weather be hot and dry it will probably be advisable to cut the crop rather earlier than the stage previously indicated, *i.e.*, with the cereals when in full flower, or if cool and showery, at a later stage.

Filling the silo.

The fodder crop when cut should be placed in the silo with as little delay as is practicable. It may be carted as fast as it is cut, or with limited labour, the cutting may be done in the morning, and the carting in the afternoon. The material is three times as heavy as hay, and low-wheeled vehicles will be found convenient for handling it, because of the ease in loading same.



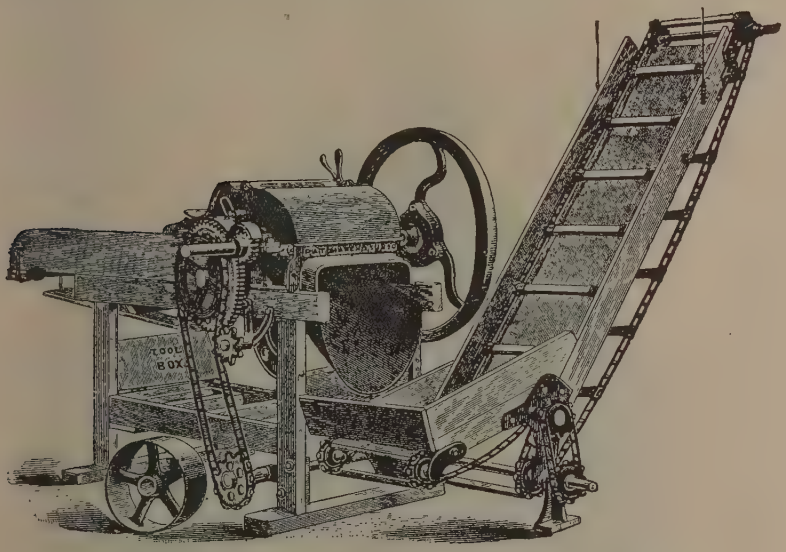
Silo with sixteen sides lined with asbestos sheeting—33 feet high.

Note the continuous doorway and low wagon for carting the heavy material, the fodder (wheat) being cut with a chaffcutter and placed in the silo by means of the slatted elevator.

Filling the silo is quite within the compass of farm operations where chaff-cutting is practised. The work can be carried out slowly even with two men who, after the crop has been cut, then load the vehicles and later feed it to the chaff-cutter and blower. These men, after the material has been elevated into the silo, then spread and tramp it before proceeding with the next load. With only two men, however, the work proceeds slowly and usually it will be found preferable to have at least three men. This number is used for filling the 100-ton silo at the Avondale Research Station and also for the smaller silo at the Meckering Research Station.

The fodder may be placed in the silo either whole or cut, but for convenience of handling and feeding the silage it is usual to cut the fodder in short lengths, *i.e.*, to chaff it. For dealing with the thick hard stalks of maize and sorghum

special silage cutters have been manufactured. These are very strongly made, and are of two types. One type is as shown in the illustration, and has the cutting knives placed around a circular frame and arranged lawn mower fashion, revolving against a cutting plate. On the other and new type the cutting knives are fixed to a vertical wheel, as in the usual chaffcutter. For cutting cereal crops like wheat and oats, the ordinary power chaffcutter is strong enough.



Silage cutter with slatted elevator. The cutter is specially suited for maize.

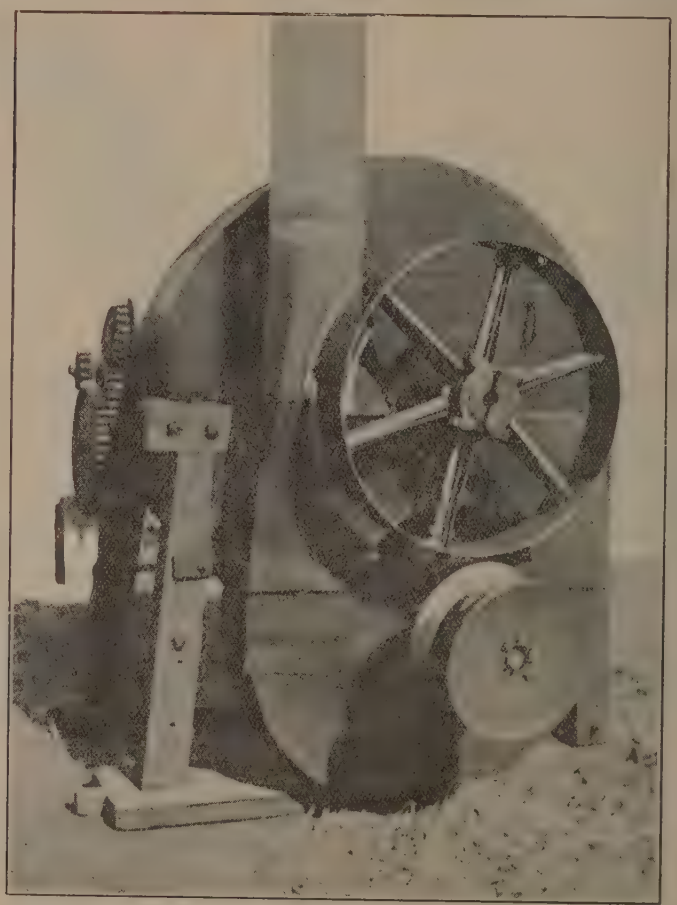
"Tower" silos are filled over the top, and because of their height it is necessary to have some mechanical means of filling them. Two methods are available—the slatted elevator, as shown in the illustration, and the air blast or blower. The latter requires more power to drive it, but requires less space and is considerably more convenient. With the former, unless driven from the top with a very long belt or with an intermediate pulley, there is some risk that the sprocket chain carrying the slats over the bottom wheel will foul each time the elevator is started.

These machines are, however, not well adapted for chaffing greenstuff of the thin-stemmed cereal type and not at all adapted for chaffing cereal and meadow hay, which is in continuous use the year round on Western Australian farms.

The chaffcutter, on the other hand, is not only particularly suitable for chaffing hay, but it is also equally suitable for cutting up the cereal greenstuff from which silage in Western Australia is mainly made. Experience has also shown that the chaffcutter is quite suitable for cutting up green maize or sorghum for feeding direct to stock, or for the silo. The chaffcutter can, therefore, be used for both chaffing hay and greenstuff, and, for Western Australian conditions, is more suitable and useful than the special silage cutter which can be used with advantage only for cutting up greenstuff.

To meet the requirements of the modern silage maker, the chaffcutter requires to have a blower elevator attachment. In the special silage cutters of the chaffcutter type, designed for cutting maize, the blower fan is fixed to the main spindle

to which is also attached the cutting wheel. Such an arrangement is not possible with the Western Australian chaffcutter, for the blower to lift the greenstuff the desired height—30 to 40 feet—has to be driven a such a high speed that the wheel of the chaffcutter, if run at that speed, would be driven at too great a speed for efficiency and safety; the chaffcuiter wheel might even be driven into pieces. To obviate this in the special silage cutters the cutting wheels are specially strength-



COMBINED CHAFF AND SILAGE CUTTER.

A "Zealandia" Chaffcutter with blower elevator attachment, made by Mr. R. D. Sims, "Waihopai," Highbury.

(*Block by courtesy of Westralian Farmers, Ltd.*)

ened, but this renders them much less suitable, if not entirely unsuitable, for chaffing hay. The difficulty of attaching a blower-elevator to the chaffcutter has, however, been overcome by attaching the blower fans to a spindle other than that to which the knife wheel is fixed. For dealing with chaffed hay Mr. H. Smith, a farmer in the Manmanning district, has had an attachment for the purpose on the market for some years.

As far as is known the first attachment to be used successfully for silage making was designed and made by Mr. R. D. Sims, "Waihopai," Highbury. An illustration of this appeared in the Journal of the Department of Agriculture* and is reproduced on page 414. This attachment has been working successfull now for seven years, and not only is it used once yearly for filling the twin silos, 28 feet high, but it is used throughout the year for filling a chaff room with chaffed hay. For this latter purpose the chaff is elevated vertically 14 feet, and then blown horizontally 12 feet along the shed and through a home-made dust extractor. The blower is attached to a "Zealandia" chaffcutter with an 11-inch mouth and normally elevates 6 to 7 tons of chaffed green material per hour, but its full capacity is greater, as two tons have been cut and elevated in 13 minutes. The blower was farm-made from harvester parts; the out-of-pocket expenses for these and for the 30 feet of 6-inch galvanised elevator piping and head-piece were £4 1s. 3d. A similar machine is in use at the Avondale Research Station for filling a silo with 100 tons capacity and chaffing hay during the year for farm requirements.

With modern machinery the silo can be filled in one or two days, if desired, but it is advisable to proceed more leisurely and to spend from four days to a week on the work. The slower rate of filling permits more fodder to be stored, as it will be found that the material will become more compact each day. Even with the slower rate of filling, a second, and even third filling may be necessary to insure that the silo will contain its normal weight.

Whilst the material is being filled into the silo care should be taken to see that it is evenly distributed over the silo. This may be done by hanging a cone just below the discharging elevator or blower, or by discharging into a pipe the mouth of which extends near to the level of the material in the silo, and by means of which the inflowing fodder can be distributed where desired. Unless these precautions are taken it will be found that in the drop from the top to the lower levels the heavy material will become separated from the lighter and most of it be deposited in the centre of the silo, whilst the latter will reach the sides. This will result in uneven settlement and consequent waste. Whilst the filling is proceeding the material should be not only well spread, but also well packed by tramping, particularly near the walls. Because of the assistance which will be given by the weight of the upper layers to compact the lower these latter need not be tramped as much as the upper ones.

When the silo is finally filled after preliminary settlements, the top-most layer which is in contact with the air, if wet enough, will decay and form an airtight layer to protect the material beneath. It is essential that this protection be afforded, and King† suggests the application of 1½ to 2 gallons of water to each square foot of surface so as to form an impervious layer by fermentation. This water can be added to the fodder as it is being chaffed. To save the waste of fodder the top may be covered with wetted chaffed straw, or other waste material.

In order to provide the packing and pressure essential to the making of the best silage, to the top layers of tower silos, some farmers have successfully adopted the practice of placing some weight on the top of the silo after being filled. This weight may take the form of logs, clay or sand, the material in the silo being protected from the last two by means of a bag or sheet. A very convenient way when the last-named is used is to place it in kerosene or petrol tins or other handy containers.

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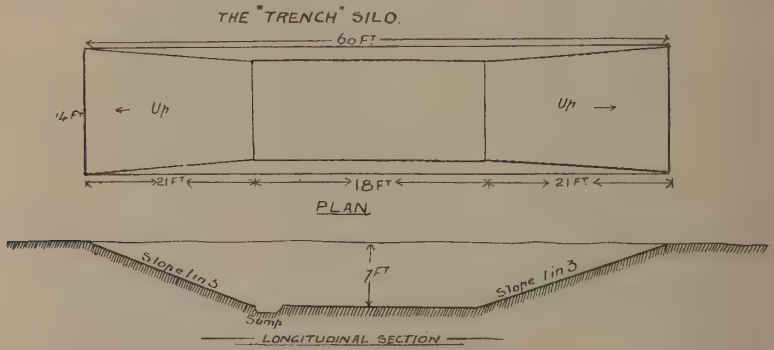
*Sutton—"A Blower Elevator Attachment to the Chaffcutter": Jnl. Agric., March '34, (2.1).

†"Physics of Agriculture."

Pit silos.

Except in the "trench" form, pit silos are rarely, if ever, constructed; they have been superseded by one or other of the above-ground types. This is not surprising, for it is obviously cheaper to enclose the necessary space above the ground than to excavate it at considerable cost before enclosing it. It may be argued that to offset this, there is less work and difficulty involved in filling the pit silo. This is so, but on considering this phase of the matter it has to be remembered that the silo has not only to be filled, but also to be emptied. In the case of the pit silo the filling may be done by gravity without labour; this is also the case with the emptying of the "tower" silo. The pit silo has, however, to be emptied by manual labour in a piecemeal fashion, and this is costly, whilst the filling of the tower silo is done in a wholesale way by power, and is comparatively cheap. The net advantage is, therefore, decidedly in favour of the tower silo.

The old pit silos were usually rectangular excavations from 10 to 12 feet deep, and lined with timber, bricks, stone or concrete; usually they were divided by a partition into two sections to prevent undue waste as the result of exposure of a vertical section, when the silage was being used. To prevent overheating the material was pressed with weights or a mechanical device. Excellent silage has been made in these with only a small amount of wastage; this was mainly in the angular corners, and on the surface.



From page 349, Vol. 1, September, 1924.

Trench silos.

The "trench" silo was first brought into prominence by Mr. John Gray, of Glencoe, Wee Waa, New South Wales, who exploited its usefulness for conserving native grasses and pasture plants. It is the modern successor of the old pit silo, and has the advantage that it can be constructed cheaply almost anywhere on the farm, and can, therefore, be used also to meet emergencies, if required.

This form of silo was fully described in this Journal by Mr. G. K. Baron-Hay,* and briefly it may be stated that a "trench" silo is a comparatively narrow excavation from 14 to 20 feet wide, and up to 12 feet deep. It is usually made with a plough and scoop, assisted with the pick and shovel, so as to have the sides almost vertical, and with as steep batters as are possible. The end batters are flatter, about 2½ or 3 to 1, so as to permit the vehicles loaded with the green fodder passing in and out. As they pass over the material whilst the silo is being filled they help to press and pack it. The material, which may be chaffed or unchaffed, is stacked

Journal of Agriculture, W.A., September, 1924.

several feet above the ground level, and then covered to a depth of nine to 12 inches with the earth taken from the sides. As the fodder settles cracks may develop in the earth covering, and if so, these should be filled up by adding fresh earth.

The silage stack.

Making silage in stacks is the most wasteful of all the methods adopted but even so under some conditions it is found advisable to use them rather than that surplus fodder which would otherwise be wasted should not be conserved. This method, however, has the advantage that it can be made without capital expenditure, but even in this respect it has little advantage over that made in the "trench" silo.

Though good silage, quite as good as in the best tower silo, may be made in stacks, the proportion of such good silage may be small, on account of the layers of waste or material of lower nutritive value in the top and sides. Because the animals eat the material from the top and sides, it is sometimes considered that there has not been waste. Such an opinion entirely ignores the great difference in food value between such material and the original fodder from which it was made.

The excessive waste in a stack, and not common to other methods, is due to the loss consequent upon the exposure of the external surfaces to the air, and in consequence a considerable portion dries out and moulds, and becomes, in effect, very inferior hay which may even be injurious to stock because of the mould. The depth to which the destructive effect penetrates is largely influenced by the character of the material; with fine stemmed material like grass and other pasture plants the depth will range from nine to 12 inches, but with coarser material like oats, wheat or maize, this will be exceeded and may reach 36 inches. The damaged material in the stack of oat silage illustrated herewith extended to this depth on the top and sides. This wastage has been calculated to equal in volume 56 per cent. of the total contents.

Very careful determinations were made regarding the wastage in a silage stack of grass and clover at the University Farm, Cambridge.*

> "Weighings of the amount of wastage by moulding on the roof, sides, and floor were made on 23rd September, and again on 8th December. On the former occasion the waste amounted to 29 per cent., and on the latter to 35 per cent., in addition to fermentation losses amounting to an average of 10 per cent. of the good silage remaining."

It will thus be seen that even though the animals may eat all the conserved material, there is always some loss or waste due to the lowered food value of some of it. As the loss is primarily due to the amount of air which is enclosed with the material when being ensiled, and later by the admission of air after conservation, then, as the air cannot as well be driven from the long material of a stack as from the chaffed material of a pit or silo, nor can the air be excluded as well from the open stack as from the enclosed pit or silo, it follows that in stack silage there will be the most waste. Consideration of the replacement of the stack by the almost equally cheap trench is essential in the dry areas, and desirable even in the wetter southern areas.

As the waste on a stack is due to the area exposed to the surface it is influenced by the shape of the stack, thus a square stack is less wasteful than a rectangular one, for there is less surface exposed to the air as the total length of all the sides of a square stack is shorter than that of the sides of a rectangular stack holding the same weight of silage.

*Amos, *Journal Ministry of Agric.*, April, 1925 (32-1).

For the same reason a circular stack is less wasteful than a square one. Despite this, however, square and circular stacks are rarely built, and only in the small sizes, and when the stock are numerous enough to ensure that a complete surface layer at least two inches deep shall be required and removed daily. When this cannot be done the stack is fed in sections made by cutting off a portion across the narrow width of the stack. The cut surface of such a section is exposed to the air, and therefore subject to wastage; in the case of a circular or square stack of greater surface area than is required for the number of stock to be fed it would be greater than in the case of a rectangular stack of the same volume, and would more than offset the initial saving. As one large stack is also more economical than several small ones, and because it is economical to feed stack silage in sections, it is, therefore, customary to build rectangular stacks with rounded corners, rather than several small square or circular ones.

The site selected for a silage stack should be well drained and levelled to obtain a good base. The stack can be built right on the ground, and requires neither a straddle nor layer of straw at the bottom. If dry straw or porous material is used at the bottom it tends to admit air, and the silage in contact with it is likely to become mouldy.

Silage stack at the Avondale State Farm, Beverley.
Note the position of the logs, which were 6 feet above the ground when attached to the wires.

If, in order to secure proper drainage for the stack, it is necessary to raise the bottom of the stack above the surrounding country by means of a log straddle, the spaces between the logs should be filled in with clay or earth to prevent the admission of air to the bottom of the stack.

The dimensions of the stack should be as large as the crop to be conserved will justify. Suggested dimensions at the base for silage stacks are—

For 25 tons—4 yards x 4 yards, or 4½ yards diameter.
For 50 tons—4 yards x 8 yards.
For 100 tons—5 yards x 10 yards.
For 150 tons—7 yards x 12 yards.

The green material, without drying of wilting, should be stacked in a similar way to hay, except that during the building of the first half of the stack the centre should be kept only very slightly "full," so that there will be no tendency for the material on the edges to slip off. In the building of the second half the centre can be raised considerably so as to assist in the shedding of rain water.

When building a silage stack it is advisable that the unloading from the vehicles should take place all around the stack, otherwise settlement is likely to take place unevenly, with a possible collapse of the stack. Should a stack show signs of undue settlement on one side a collapse can probably be averted by placing props against that side until the other side has settled to a similar extent.

The walls of the stack should be almost vertical, or very slightly drawn in to the top; overhanging eaves, as in hay stacks, are most undesirable and tend to wastage.

The stack should be built as high as possible—18 feet or higher—for silage settles much more rapidly and to a greater extent than hay.

With stack silage there is such a tendency to overheating that the building of the stack should proceed as rapidly as possible; constant and regular packing by tramping should take place whilst the building is going on, and plenty of pressure should be applied as soon as the stacking of the material is completed.

Delay in building the stack or in applying pressure is likely to result in the inclusion or admission of excessive air with an unnecessarily high temperature. This will cause increased loss of dry matter, and a further decomposition of, and depression of, the digestibility of the protein constituents.

When the stack is completed the material should be compressed in any suitable way to keep out the air. A cheap and convenient method of compressing the stack is to place poles lengthways on the stack, and across these stretch a number of fencing wires to the ends of which are attached logs, fencing posts, or other heavy material. The logs, etc., should be suspended at least six feet from the ground. If the stack is to go through the rainy season it will be necessary to cover it so as to protect it from the rain.

It is possible that the dried and other material which is found on the outside of stacks, and which is definitely not silage, may be eaten readily by the stock, and because of this, farmers may consider that there has been no waste of the nutrients in the food. This, however, is not so, as this material is certainly not nearly as nutritive as the crop from which it was obtained, nor of the conserved silage, and, in consequence, there is a very definite loss of nutrients. Because of this, consideration of the replacing of the silage stack by the almost equally cheap trench silo is essential in the dry areas and desirable even in the wetter southern areas.

Silage will keep indefinitely and is suitable for dairy cattle and other stock.

Silage may stay in the silo for two or more years without deterioration. Several cases of silage being held for at least 10 years are on record, and the writer recollects seeing a statement to the effect that silage had been kept in France for 119 years, but cannot at present trace the reference. Because the modern dairy cow is required to produce three or four times the quantity of milk sufficient for its calf, succulent foods are essential in its ration. Good silage, because of its succulence, and because it more nearly approximates good pasture than any other form of conserved food, is therefore pre-eminently adapted for dairy cows, and in consequence it is more in favour with dairymen than with any other class of farmer.

It promotes and maintains the milk flow, but it is not a complete food in itself; it should be fed with hay or grain, and when this is done 30 to 40 lbs. per day is regarded as a satisfactory ration.

Feeding the silage.

At one time it was thought that the green fodder had to remain in the silo or stack for six or eight weeks until the fermentation period was over before it could be fed. This is not so. Though a period of about a fortnight is necessary for the fodder to acquire the characteristics of silage, the feeding out can commence at once or be delayed indefinitely. When the feeding out has commenced it may continue until the silo is empty, or, if only a part is fed, it can be covered again with straw, or with a cover formed from the decay of the surface layer, and left until required; it can also have fresh material placed on the top of it. Thus the material in the silo can be fed at any time, can be added to at any time, and, provided the air is excluded, it will keep indefinitely.

The easiest way, therefore, of feeding green fodder is through the silo. This is of very considerable economic importance to the farmer, for it enables him to leave his green crop until it has reached its maximum feeding value; it can then be handled in a wholesale and economical manner through the silo, thus leaving the land vacant for another crop.

Though silage has a strong characteristic smell, good silage may be fed during milking. Some silage with a very strong odour is preferably fed after milking. As milk is peculiarly susceptible to the absorption of odours, care must be taken in feeding it to milking animals, to avoid every chance of this strong odour being absorbed by the fresh milk, and milkers, if they have been working with silage, should take care that their hands and clothes are thoroughly freed from the smell before they commence milking.

Sheep do well on silage, but American experiments indicate that it has no special value over dry foods for fattening sheep. In Western Australia it is probable that its succulence, and therefore laxative character, gives it a special value over hay for lambing ewes in the agricultural areas. With silage forming part of the ration, lambing can take place at any time, and as early as desired, without waiting for the usual autumn rains, and consequent growth of early pasture. For sheep 4 lbs. of good silage is considered equal to 1 lb. of good hay. The amount fed to sheep should not exceed 5 or 6 lbs. per day, and from 1 to 2 lbs., with some grain or hay, is considered more satisfactory than the maximum amount of silage.

Silage can be fed to horses with advantage, provided it is fresh and the amount does not exceed 20 lbs. per day. It should be fed in small amounts at first, and preferably with chaffed hay. The addition of silage to the rations for horses will probably lessen the occurrence of colic amongst them.

Pigs will eat silage; American experiments, however, indicate that silage is not a profitable food for pigs, and though a small quantity tends to keep them in a thrifty condition, it could not take the place of even a part of the grain ration.

Silage versus hay.

Silage, however it may be made, differs from hay, principally in that it retains the *succulence* as well as the nutrients of the fodder from which it is made.

The principal differences between hay and silage may be contrasted as hereunder:—

Hay is dry.	Silage is succulent, and therefore *laxative* and more palatable.
Hay requires dry weather for perfect making.	Silage can be made in showery or any weather.
Hay can be burnt.	Silage cannot.
Hay cannot be made from some plants, *e.g.*, variegated thistles.	Silage can be made from some plants unsuitable for hay.
Hay is subject to attacks from mice and other vermin.	Silage is practically safe from these attacks.
Hay preserves the weed seeds.	Silage has the weed seeds destroyed in it.
Hay is light.	Silage is heavy.

Because of the succulence it retains, silage more nearly resembles good pasture than any other conserved fodder. Good succulent pasture is recognised as the ideal basal ration for milking cows. Silage is, therefore, pre-eminently adapted for use by the dairy farmer during periods of scarcity, or when pastures lose their succulence. Just as the fly-wheel of an engine during periods when its power is not fully taxed stores up energy for use in time of stress, so the silo stores up succulent forage during periods of plenty for use during dry periods, and may, therefore, be termed the "Fly-wheel of the Dairy Farm."

It must be emphasised, however, that cereal silage is not a complete food in itself, and particularly for milking cows, as it contains too small a proportion of protein. Formerly this was considered also to be the case even when the green fodder is a mixture containing legumes, owing to the breaking down of the true protein during ensilage. In view, however, of the work of Watson and Ferguson (*vide* footnote page 399) this opinion has to be reviewed, and it may be concluded that silage made from material containing an adequate proportion of legumes to give a high protein content will provide a balanced food suitable for milk production. Subterranean clover or cereals mixed with a large proportion of peas or other legumes are common examples of crops used to make silage of the high quality referred to.

For a cow in milk a full ration of silage is 35 to 40 lb. No matter how suitable the quality of the silage may be for milk production such an amount will not be sufficient to provide the requisite quantity of dry matter for high producing cows; for such it will be necessary to supplement the silage ration with concentrates, or a mixture of hay and concentrates.

For sheep, silage is a formidable rival of hay, as a conserved fodder. If the hay can be fed in the long—unchaffed—state, it will be cheaper than silage. This is because hay in this State can be made as readily as silage, with a minimum loss of nutrients, and can be stacked on cheap straddles in the open or in inexpensive open sheds, whereas the most economical method of making silage is in a "tower" silo, which involves a capital expenditure of from 40s. to 54s. per ton capacity, as well as additional expenditure for the filling plant.

The interest and depreciation on the capital expenditure involved adds to the working expenses connected with the conservation of green fodder as silage, as does also the handling and carting of the extra weight of green material. Assuming that the extra cost amounts to 18s. for the equivalent of one ton of hay (say three tons of silage), then the cost of providing sheep with 2 lbs. of succulent silage per day as part of their ration for three months will cost sixpence (6d.) per head more for that period than if the sheep were given an equivalent amount of dry hay per day, say ¾ lb. If, however, the conditions of a particular farm require that the hay shall be chaffed, then it is believed that succulent silage will be cheaper

to feed than dry chaffed hay, for the added cost of chaff-cutting and bagging will more than offset the additional charges associated with the production of silage, and already referred to.

Silage, because of its succulence, which causes it to be laxative, has a special value as part of the ration for lambing ewes when on dry feed, and in consequence the feeding of silage to such stock is probably justified, even if the extra cost be involved.

SUMMARY.

Silage-making is of great antiquity, and was introduced into Western Australia at the beginning of the present century.

Silage provides a means of conserving fodder in a succulent condition. It is excellent for dairy cows, useful for sheep and horses, and, to a limited extent, also for pigs.

The green fodder is preserved on consequence of the exhaustion of the oxygen in the air within the mass.

The primary and essential causes of the changes during ensilage are the respiratory action of the plant cells whilst living, and enzyme activity before and after their death; other subsidiary and non-essential changes may occur, and are due to bacterial activity. The changes are accompanied by considerable self-heating, which results in the loss of dry matter, principally carbohydrates, and also in the decomposition of portion of the true protein. The products which result from the decomposition of the proteins are not lost, they still have an energy or nutritive value. They are, however, not suitable for and cannot therefore be utilised by the animal for the building and repair processes for which the true protein as originally found in the fodder was alone suitable. The resulting nitrogenous compounds are, therefore, less valuable as food than the protein from which they are derived. The changes which take place during ensilage hinder the development of moulds and prevent decay, and so silage will keep good as food for a long time.

All kinds of silage have a sour taste, some have also a more or less pronounced acid smell, and some an objectionable aroma. This is due to the formation of organic acids during ensilage and consequent upon the partial oxidation of the dry matter. The principal acids formed are acetic and lactic acids. If the former predominate the silage will have an acid smell, and be known as "acid" silage; if the latter are in excess the distinctly acid smell will be absent. An unpleasant aroma is due to the presence of butyric acid, and is an indication that the silage is partially spoilt.

The different forms of silage have been classified as "sweet," "acid brown," "green fruity," "sour," and "musty" silage.

The last two are defective. "Green fruity" and "acid brown" are the best, and are made as the result of ensiling the crops at the proper state of maturity, and maintaining comparatively low temperatures below 90deg. F. "Sweet" silage is produced when the higher temperatures of 113deg. F. to 122deg. F. are reached.

Even when the comparatively high temperatures associated with the production of "sweet" silage are reached, the total loss of dry matter need not be excessive. It is probable that in well made silage the loss of nutrients does not exceed that which occurs in well made hay.

As the decomposition of portion of the true protein is unavoidable during ensilage, and such does occur to the same extent in well made hay, it follows that unless there are very special reasons for doing otherwise leguminous crops like lucerne, clover, peas, etc., which are specially rich in protein, and which are usually grown to supply farm protein deficiencies, should be made into hay rather than into silage.

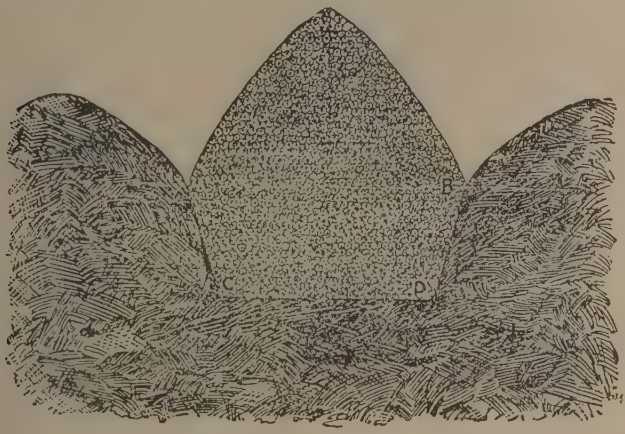
To make good silage the plants must be harvested at the proper stage of maturity, *i.e.*, when they contain not less than 66 per cent. of water, nor more than 74 per cent., and *air excluded* from the mass by packing and pressure in order to keep the temperature as low as possible.

Good silage can be made from many plants, including native grasses and pasture plants. On farms it is usually made from cultivated crops, as the winter cereals, and maize, sorghum, and Sudan grass. The cereals should be cut when in flower, and the maize when dented.

Rape and other plants belonging to the cabbage family are considered unsuitable for silage.

Silage can be made in silos, above or below the ground, and in stacks. Above ground or "tower" silos should be circular and deep, have smooth rigid walls, and be fitted with an almost continuous doorway. "Pit," or below ground silos are giving place to the "tower" silo. The "trench" silo is the modern successor of the old pit silo, and consists of a narrow excavation made largely with plough and scoop.

Stack silage is the most wasteful of all methods, owing to the large amount of spoiling which takes place on the sides and top. On occasions its use may be justified.



Section of filled "trench" or "clamp" silo ready for covering with earth from the sides.

Silos should be emptied by removing the whole of the surface daily; experience has shown that not less than 1¾ inches, and preferably 2 inches, should be removed daily. The diameter or surface dimensions of the silo are, therefore, governed by the number of stock to be fed. The depth is determined by the period during which the silage is required to be fed.

The silo provides the easiest way of feeding green fodder; the material can be fed to stock as soon as placed in the silo, or at any time afterwards. It can be added to at any time, and will keep indefinitely.

Because of its succulence, silage is an excellent substitute for good pasture, and is, therefore, pre-eminent as a conserved fodder for milking cows. It may be regarded as "The Fly Wheel of the Dairy Farm."

For sheep, silage is a formidable rival of hay. It is slightly more costly to produce than long hay, and less costly than chaffed hay. Because of its succulence its use—even at a slightly higher cost—is probably justified, particularly for lambing ewes.

PIG FEEDING EXPERIMENT CONDUCTED ON "TIPPERARY" FARM, BURGES SIDING.

GEO. L. SUTTON, Director of Agriculture,
and
G. K. BARON-HAY, Superintendent of Dairying.

During the last three years a number of experiments have been conducted at the Denmark Research Station and at Mr. W. G. Burges' Farm, "Tipperary," view a view to obtaining information regarding the suitability for the export bacon trade to Great Britain of those breeds of pigs which predominate in Western Australia, namely, Tamworth, Berkshire, Large White, and their crosses.

The reports from London indicated that, irrespective of breed, the carcases suffered from the same faults, namely, too thick a layer of fat along the back, and absence of "streak" in the bacon. The three breeds investigated were the Tamworth, Berkshire, and Large White, and crosses between these breeds; and, as the reports were the same for each breed, the suggestion was made that the remedy might be in an amended system of feeding.

In the trials referred to above, the rations fed consisted of ground wheat, milk, and meatmeal, adjusted so as to give the orthodox amounts of protein and having the orthodox nutritive ratio. This being so, it was difficult to see how the ration could be improved to obtain a greater proportion of lean meat to fat.

In adopting these rations, the view that those animals which grow the most rapidly are the most economical and most profitable was accepted. If this be so, then very few farmers are feeding their pigs along these "most profitable" lines, as, even the rations fed at "Tipperary" are adopted by only a few farmers in the State at present.

The suggestion that the orthodox ration may not produce the best quality carcase was made to Mr. Burgess and the authors by Mr. D. T. Bantock when inspecting a line of bacon carcases at his factory, and which were considered particularly prime quality.

Mr. Bantock suggested that the back fat could be reduced, and a leaner, more streaky side of bacon be produced by adding a small quantity of good chaff to the ration.

Mr. Burges subsequently tested out this theory by feeding his usual ration consisting of ground wheat and meatmeal, but to which 10 per cent. of good oaten and pea chaff was added. The pigs took approximately 30 days longer to mature, and, from inspection on the farm, appeared to be more lengthy and to carry less fat than the normally fed pigs.

Messrs. Foggit, Jones Pty., Ltd., Belmont, to whom the pigs were consigned, reported that the pigs were most suitable for the local trade, and in their opinion an improvement in quality on previous consignments and those usually received at this time of the year, *i.e.*, summer.

It was thought desirable to conduct a controlled feeding trial, with a view to ascertaining the effect of reducing the grain ration by substituting a portion of it with good chaff.

It might be stressed here that pigs require a considerable proportion of fibre in their daily ration, and that, where the open run system of pig-raising is followed, this fibre may be supplied during the winter months by grazing either on pasture or on green crops sown for the purpose. During the dry summer months,

however, when there is no grazing, special provision must be made to include this necessary fibre by some other means. The only practical method—throughout a large portion of the State—of supplying fibre during this period is by chaff or meadow hay, the latter for preference.

While the experiment was conducted primarily to ascertain information regarding feeding for a lean carcase, several points of distinct interest were brought out during the trial. On 31st January, 1936, 52 pigs from a number of litters, but all sired by a Canadian Berkshire boar recently imported from New Zealand, were selected and divided as evenly as possible by appearance and weight into two equal lots.

The pigs were weighed regularly at monthly intervals, the food consumption, however, being carefully recorded and changed from time to time as the appetites of the pigs required it. Each month, or more often if necessary, any pigs which had reached bacon weights were weighed and consigned to Messrs. Foggit, Jones Pty., Ltd., Belmont. The pigs were then inspected and graded on the hoof, and again inspected after slaughter. Subsequently 14 carcases were forwarded to England for a general report, and a detailed report on eight of these carcases as to their suitability for the British bacon trade.

The meal rations of the two lots were as follow:—

	Lot 1 (Mixture A).	Lot 2 (Mixture B).
Crushed Wheat	72	81
Meatmeal	8	9
Oaten Chaff	20	10
Skim Milk—1 quart per pig per day.		
Nutritive Ratio, including Skim Milk ...	5·3	5·1

Throughout the experiment one quart of skimmed milk per pig was available per day. The nutritive ratio is wider than usually recommended, but recent work in England tends to show that pigs fed to produce most rapid gains do not produce the highest quality carcases.

The method of feeding was to give each lot of pigs (which were fed in long troughs which give ample room for feeding) all the above mixtures that they could consume in about 15 minutes, feeding being carried out twice per day.

The following table sets out the quantities of the meal mixtures consumed per pig by the two lots of pigs.

TABLE 1.—WEIGHTS OF RATIONS CONSUMED.

Date.	Lot 1 (Mixture A).		Lot 2 (Mixture B).	
	Daily.	Total.	Daily.	Total.
1936.	lb.	lb.	lb.	lb.
Feb. 6–14	1½	13½	1½	13½
,, 15–27	2	26	2	26
,, 28–Mar. 7	2½	20½	2½	22½
Mar. 8–14	2½	17½	3	21
,, 15–27	3	39	3½	45½
,, 28–Apl. 2	3½	17½	4	20
Apl. 3–9	4	28	4½	31½
,, 10–16	4½	31½	5	35
,, 17–May 8	5½	121	6	132

The first consignment of pigs was sent to the factory on 8th May, the last pigs being marketed on 5th June, the grain ration fed from 8th May being at the same rate as during the last period in the table above.

Table 2 shows the daily gain in live weight per pig in each lot. During the first month, each lot received the *same weight* of food, which resulted in pigs in Lot 2 not being satisfied, their ration not being so bulky as for those in Lot 1. It was noticed, however, that in the first few weeks of feeding, Lot 1 receiving the higher percentage of chaff did not appear to thrive as well as the pigs in Lot 2, but, during the last three months, the gains in each lot were more rapid, although those of Lot 1 (chaff 20 per cent.) never equalled those of pigs in Lot 2 (chaff 10 per cent.).

TABLE 2.—DAILY GAIN IN LIVE WEIGHT PER PIG.

—	Number of Pigs.	Initial Average Weight, Jan. 31.	Average Gain in Pounds Live Weight each Month.						
			Feb. 27	Mar. 27.	Apl. 24.	May 8.	May 21.	June 5.	Average Increase per Day.
Lot 1	27	54·6	0·70	0·79	1·14	1·29	1·31	1·47	1·05
Lot 2	25	55·5	0·67	0·93	1·43	1·57	1·61	...	1·21

Table 2 illustrates what might be expected—that pigs on the high fibre ration in Lot 1 did not grow at such a rapid rate as those on the normal ration, and were found to take 10 to 14 days longer to attain bacon weights.

The average age at which pigs were marketed was 27½ weeks in Lot 1, and 25½ weeks in Lot 2.

The next inquiry was the effect of this restriction in growth on—

(a) the quality of the carcase; and

(b) the relative cost of feeding.

(a)—*Effect on Quality.*

Taking the consignments from each lot as a whole, neither the authors nor the manager of Messrs. Foggit, Jones' factory was able to distinguish a difference in quality among pigs from either lot—either "on the hoof" or after slaughter. The pigs, however, as a line, were pronounced among the best that had ever been received at the factory. Unless, therefore, there was some economic advantage to be gained through increasing the percentage of chaff fed above 10 per cent., the practice cannot be recommended, as there is no apparent improvement in quality by doing so.

Two pigs which had rather less than the desirable quantity of fat were from Lot 1.

(b)—*Cost of Feeding.*

TABLE 3.

—	Average Gain per Day.	Average Total Mixture per Pig.	Average Mixture per 1lb. Gain.	Cost of Mixture per 1lb. Gain.	Total Cost of Food, including Skim Milk.*
	lb.	lb.	lb.	d.	s. d.
Lot 1 ...	1·05	452	3·90	2·13	21 8
Lot 2 ...	1·21	419	3·61	2·36	23 3

* Skim milk at ½d. per gallon—Lot 1 28 gallons and Lot 2 25 gallons per pig.

It will now be seen from Table 3 that the cost of feeding these two lots of experimental pigs was practically the same, as the small difference of 1s. 7d. per pig is not a significant one. There is, therefore, apparently no advantage in feed-

ing larger quantities than 10 per cent. of chaff in the grain ration, as not only is there no improvement in quality, but there is the extra labour involved in feeding for a further 10 to 14 days.

Age at which to commence feeding fibre.

By dividing the experimental pigs into age groups in each lot, as in Table 4, some indications were obtained as to the ages at which young pigs may be placed on what may be termed the "standard ration" for growing bacon pigs.

TABLE 4.—GROWTH ACCORDING TO INITIAL WEIGHT.

Initial Weight.	Lot 1.—20 % Chaff.				Lot 2.—10 % Chaff.			
	Average Initial Weight.	No. of Pigs.	Average Gain 1st Month.	Average Gain 2nd Month.	Average Initial Weight.	No. of Pigs.	Average Gain 1st Month.	Average Gain 2nd Month.
lb.								
30 and under ...	29	1	6	12	29	1	10	18
40 ,, ...	34·7	3	12	20·3	37	2	12·5	18
50 ,, ...	45·3	6	17	19·4	46·9	7	13·7	23·4
60 ,, ...	54·3	7	18·7	23·3	55·8	6	16·4	25·5
70 ,, ...	65·4	8	21·1	25·6	67·0	7	22·0	32·6
80 ,, ...	72·0	1	31·0	29	75	1	27	35
90 ,, ...	...	...	...	...	84	1	27	39
100 ,, ...	93	1	32	40	...	...	...	...
Average all Weights ...	54·6	27	18·7	23·2	55·5	25	17·5	27

Although the number of pigs was small in the lower weight groups, the indications are that in neither lot were the younger and smaller pigs able to consume and thrive on rations where 10 per cent. or more of chaff had been added. This is in accord with standard practice, as in the feeding of oats, for instance, this grain is not recommended for young pigs, owing to its high fibre content.

The indications are that young pigs should be kept on a ration comparatively low in fibre until they attain over 50 lb. live weight, after which the standard ration containing 10 per cent. of chaff can be introduced with profit. This normally would be at an age of 12 to 13 weeks.

Increase according to breed.

As mentioned earlier in this article, the sire of all the pigs was an Improved or Canadian Berkshire boar. The sows comprised four grade Tamworths, one Tamworth x Berkshire, one pure-bred English Berkshire, and one Canadian Berkshire sow.

Table 5 sets out the average gain per day of each breed.

TABLE 5.—AVERAGE GAIN PER DAY ACCORDING TO BREEDING.

Breed.	Lot 1—Chaff, 10%.		Lot 2—Chaff, 20%.	
	No. of Pigs.	Increase per Day.	No. of Pigs.	Increase per Day.
Canadian Berkshire x (T x B)	5	·98	5	1·25
Canadian Berkshire x Tamworth	14	1·06	12	1·13
Canadian Berkshire	4	·98	1	1·40
Canadian Berkshire x English Berkshire ...	...	...	5	1·05

The differences between the various crosses of the Tamworth and the Berkshire in Lot 1 are not significant.

In Lot 2, however, there is a significant difference between the Canadian Berkshire x (Tamworth x Berkshire) and Canadian Berkshire x Engish Berkshire pigs, indicating that the English Berkshire type is rather slower at maturing than the Tamworth cross. The exceptionally high gain in the case of the one Canadian Berkshire Barrow in Lot 2 cannot be regarded as a breed characteristic, as, in all breeds, these outstanding individual pigs occur, which have the capacity of converting their food into meat exceptionally economically, and are popularly referred to as "good doers."

Such another pig was No. 110 in Lot 2, a Canadian Berkshire x English Berkshire, which averaged a daily increase of 1.63 lb.

As these pigs were not fed separately, the increase may be due to abnormal food consumption, and not to greater efficiency in food utilisation.

It has not yet been proved whether this abnormal performance has a genetic origin and is capable of being reproduced, or whether it is due to some pathological cause and, therefore, accidental. In this case, the four litter relatives of this outstanding pig were rather below the average gain than above it. Be that as it may, however, the custom is to assume that this capacity can be passed on to the progeny, and such pigs are commonly selected as breeding sows, and rightly so.

Considerable controversy is often noticed regarding what is a reasonable percentage loss to allow on pigs between their weight on the farm and that after slaughter.

The losses incurred in these experimental pigs are shown in Table 6. "Tipperary" is only 60 miles from Bellevue by rail, and pigs are only about five hours en route, so the figures given for losses en route would be considerable greater where longer distances are travelled. Moreover, all these pigs were "hard grain" fed, which further reduced the losses in comparison with those where pigs are "grass" fed or "skim milk" fed, to the almost total exclusion of grain.

TABLE 6.—LOSS IN MARKETING.

	Lot 1.		Lot 2.		Average, Lots 1 and 2.	
	lb.	%	lb.	%	lb.	%
Average Weight at "Tipperary" ...	171	...	180	...	175	...
Average Loss en route	...	2·3	...	3·6	...	2·9
Average Loss on Slaughter (warm) ...	...	22·7	...	22·0	...	22·3
Total	...	25·0	...	25·6	...	25·2

To this average percentage loss of 25.2 per cent. must be added a further 2 per cent. loss between the "warm" carcase weight and the "chilled" weight, and, where pigs are purchased on rails, a further percentage should be allowed for the risk of loss due to accident, which is particularly heavy during the hot summer months; 3 per cent. is not an unreasonable percentage on this account. It would appear, therefore, that for "grain fed" pigs a 30 per cent. allowance for loss from farm to carcase weight at factory is not unreasonable.

SUMMARY.

1. As in the previous trials, it has been again demonstrated that crushed wheat and suitable quantities of meatmeal can be used for the economic feeding of pigs, even although very limited or even no skim milk is available.

2. The roughage necessary for maintaining pigs in health can be provided in wheat belt areas by an addition of good chaff to the grain ration.

3. The feeding of more than 10 per cent. of the grain ration in the form of chaff is of doubtful value, as, during the delay in the maturing of pigs, the extra ration consumed raises the cost to the same as that in the case of the lower percentage of chaff.

4. The addition of roughage in the form of chaff does appear to increase the streakiness of the resultant bacon, *i.e.*, the lean meat is distributed through the fat in the sides and belly.

5. The pigs uniformly showed a thinner layer of back fat than in other consignments fed on a similar ration, without chaff.

6. There was no significant difference in the daily increase in weight between the various crosses of the Berkshire and Tamworth pigs used.

7. Although the number of pure-bred Canadian Berkshire pigs included in the experiment was small (4), each of these pigs produced an excellent bacon carcase, and the best carcase in the whole consignment was adjudged to be one of these Canadian Berkshire pigs. There is a strong indication, therefore, that this type of Berkshire is that required for trade purposes both for the local market and for export.

8. Young pigs of less than 50 lb. live weight., *i.e.*, approximately 12 weeks old, should not be fed the ration with the chaff added. Such pigs require a ration with a higher protein content and less fibre.

It is desired to thank Mr. W. G. Burges, "Tipperary," York, for permitting the experiment to be conducted at his farm and for supplying the labour in connection with feeding and weighing, also Mr. T. P. Massey, manager of Messrs. Foggit, Jones Pty., Ltd., and Mr. Ellary, works manager, for their assistance in slaughtering, judging, and cutting of the carcases.

INTESTINAL PARASITES AND PARASITIC DISEASES OF SHEEP.

A REVIEW.

A. McK. Clark, L.V.Sc.,
Chief Veterinary Surgeon.

"The Intestinal Parasites and Parasitic Diseases of Sheep," by Dr. I. Clunies Ross and Mr. H. L. McL. Gordon, has been written by two research workers whose investigations into this particular phase of sheep diseases have been of outstanding merit. It is the more valuable as it not only comes from two authorities on intestinal parasites in sheep but it fills in adequately a portion of a large gap in literature appertaining to sheep diseases in Australia.

The substance of the book is of threefold significance. It is a reference for the veterinary surgeon, is an excellent text-book for the student, and to a certain extent accommodates the requirements of the sheep breeder. The photographic plates and diagrams are particularly clear and instructive, and our thanks are due to the authors for this valuable contribution to veterinary literature on sheep diseases.

It is to be hoped that this will stimulate workers in other sheep diseases to complete the remaining gaps existing in veterinary literature on sheep diseases in Australia.

RELATIVE FOOD VALUES.

RELATIVE VALUES OF CONCENTRATES.

Perth, July, 1936.

Foodstuff.	Cost.	Cost per 100lbs.	Starch Equivalent per 100lbs.	Digestible Protein per 100lbs.	Cost per lb. of Starch Equivalent.	Cost per lb. of Digestible Protein.
		s. d.	lb.	lb.	d.	d.
Wheat	3s. 10½d. per bushel of 60lbs.	6 5½	83	10·2	·93	7·6
Oats	2s. 5½d. per bushel of 40lbs.	6 1½	71	8·0	1·04	9·22
Bran	£6 17s. 6d. per ton ...	6 10½	54	14·6	1·53	5·65
Pollard	£6 17s. 6d. per ton ...	6 10½	80	15·5	1·03	5·32
Linseed Meal ...	12s. 6d. per 100lbs. ...	12 6	80	29·0	1·87	5·17
Meat Meal (W.A.) ...	12s. per 100lbs.	12 0	100	65·0	1·44	2·21
Peas	7s. 9d. per bushel of 60lbs. ...	12 11	84	22·0	1·84	7·04
Sub. Clover Hay ...	30s. per ton	1 4	44	10·8	0·36	1·49
*Young Subt. Clover Pasture ...	20s. per ton	0 10½	65	19·0	0·16	0·56
Subt. Clover Silage	10s. per ton	0 6	43	9·4	0·14	0·64

* Dry matter.

The table shows that for the supply of energy or fat-forming foods, among the grains, wheat, oats, and pollard are approximately the same value.

For the provisions of protein or flesh-forming foods, meatmeal is the cheapest concentrate to buy, followed by linseed meal.

No purchased concentrate, however, can compete with young clover pasture or clover silage in economy of production.

MAMMITIS OR MASTITIS IN DAIRY COWS.

A. McK. CLARK, L.V.Sc.,

Chief Veterinary Surgeon.

Mammitis or Mastitis is an inflammation of the udder caused by the invasion of that organ by microbes or germs. It is prevalent in dairy herds, and especially so in cows of high production. The predisposing cause is weakened resistance consequent upon calving or exposure to cold. It must be understood, however, that the causal germ or germs must be present, and these invariably exist in apparently normal cows.

Mammitis is spread from cow to cow by means of the milkers' hands or milking-machine cups. In order to control the spread of this disease, the following advice is offered:—

A. PREVENTION.

Careful selection of cows should be made prior to their introduction into clean herds. The purchase in saleyards of cows stocked with milk should be guarded against unless the four quarters are uniform in size. The detection of mammitis is best made after the udder is stripped of milk. It can then be thoroughly examined with the hand.

B. CONTROL.

(a) *Early Detection of the Disease.*

(i.) Acute Stage—Acute Inflammation.

Cow is irritable when milked, and tenderness of the udder will be observed. Sometimes the udder is noticed to be swollen, and milk becomes watery. As recovery takes place, clots of pus can be drawn with the watery milk. Heat in the udder and redness will at times be apparent in extremely inflamed quarters. If machine milking is being carried out, all udders should be hand stripped and examined for the above symptoms.

(ii.) Chronic Stage—Chronic Inflammation.

This condition will not be observed unless the udder is stripped of milk. On manipulation of the udder more or less hard tissue will be felt in the form of a lump or lumps. After milking machine cups have been removed, udders should be stripped with the hand and examined to detect this condition.

(b) *Isolation of Affected Cows.*

Cows with affected udders should be isolated from those which are not affected.

It should be recognised that the disease is spread from cow to cow by the hands of the milkers or milking machine cups. The hands should be immersed in a solution of permanganate of potash (Condy's crystals) after milking affected cows. When mammitis is prevalent in a herd, the udders of the cows should be washed prior to milking with a solution of Condy's crystals. The strength of the solution should be determined by thoroughly dissolving the crystals in water until it assumes a light port-wine colour (8¾ grains to the pint). THIS SOLUTION SHOULD BE FRESHLY MADE UP EACH DAY. When treating affected cows which have been isolated, these should be done after all milking has been completed.

(c) *Treatment.*

No infallible treatment is known. Affected cows should be milked out thoroughly two or three times daily and the milk not used. The affected quarter or quarters should be milked into a tin or bucket containing a solution of some well known disinfectant. After stripping thoroughly, the affected quarter or quarters should be massaged with camphorated oil or pure lard. Care should be taken that all clots are extracted from the quarter when stripping, otherwise the teat duct may become permanently blocked.

Note.—Vaccines are manufactured for the prevention and treatment of mammitis. These should be used with caution. The Veterinary Branch of the Department of Agriculture should be consulted and their advice solicited before attempting the use of these vaccines.

METEOROLOGICAL INFORMATION.

STATIONS.	TEMPERATURE.				RAINFALL.		TEMPERATURE.				RAINFALL.		TEMPERATURE.				RAINFALL.	
	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.	Maximum.		Minimum.		For Month.	Average.
	Mean.	Highest.	Mean.	Lowest.			Mean.	Highest	Mean.	Lowest.			Mean.	Highest.	Mean.	Lowest.		
	JUNE, 1936.				inches.	inches.	JULY, 1936.				inches.	inches.	AUGUST, 1936.				inches.	inches.
Chapman Research Station	67·4	76·8	47·1	38·6	5·90	4·17	65·1	78·4	44·3	39·9	2·48	3·95	68·0	77·8	48·1	42·1	2·64	2·80
Geraldton	69·2	74·2	54·0	42·2	4·69	4·75	66·9	74·1	50·4	40·2	2·90	3·90	69·7	80·6	54·7	45·0	2·34	2·89
Waiebing	62·3	72·5	44·8	35·0	3·86	3·99	60·9	68·3	40·8	33·5	1·88	3·77	63·2	70·5	44·6	36·5	3·65	3·12
Perth	63·4	72·8	49·4	41·0	7·43	7·04	62·4	67·8	46·8	38·6	4·89	6·79	64·8	71·4	52·0	42·2	7·26	5·71
Kalamunda	60·9	69·1	46·9	39·2	11·87	8·17	59·7	66·2	45·4	40·4	5·32	6 79	61·3	68·3	48·3	42·0	11·13	6·84
Bunbury	62·9	69 0	46 6	34·2	6·90	7·11	61·6	66·6	45·6	33·8	4·36	6·80	63·4	73·0	50·7	38·7	4·32	5·25
Bridgetown	62·0	69 5	39·2	28·5	6·40	6·02	61·8	67·8	37·9	29 5	3·81	5·87	62·1	69·8	42·9	31·0	6·70	5·08
Albany	61·6	69 1	46·7	37·0	4·84	5·50	61·1	70·1	46·1	35·2	3·20	5·61	61·6	68·5	48·2	40·5	4·96	5·28
Merredin Research Station	61·7	72·5	42·3	31·0	1·92	1·82	60·3	75·6	40·1	32·0	1·21	1·88	63·9	74·6	44·1	32·0	1·54	1·55
Northam	62 9	72·8	42·2	32·0	3·30	3·28	61·8	69·2	41·5	34·4	2·32	3·49	64·5	70·6	47·0	36·4	3·41	2·60
York	61 9	72·0	42·6	30 0	4·66	3·30	61·2	69·2	41·2	33·0	2·45	3·42	63 9	69·0	46·2	35·0	4·64	2·82
Narrogin Research Station	57 8	67·1	42·2	32 2	5·23	3·65	56·4	65·8	40·4	30·6	2·08	4·20	60·0	65·6	44·3	33·1	3·38	3·17
Katanning	57 8	66·7	42·1	31·3	3·38	3·00	57 6	66·7	40 0	29·8	1·55	3·09	59·3	65·3	44·2	34·0	2·75	2·46
Cape Leeuwin .	61·6	68·0	51·8	46·0	8·32	7 12	59·4	63·6	52·3	46·9	5·58	7·34	60·2	54·8	52·9	45·5	6·11	5·30

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